


RAILWAY TRAINING BY RAILWAY MEN
FOR RAILWAY MEN

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THOMAS H. RUSSELL, M.A., *Editor-in-Chief*

RAILWAY SHOP ADMINISTRATION

**A Practical Training Course for Men Occupying
Positions as Railway Foremen and for Men
in the Ranks Who Aspire to Rise
to Supervisory Positions**

BALDWIN-WALLACE COLLEGE

By
ERNEST CORDEAL

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Pacific Railway Company



IN TWO VOLUMES

VOL. I

RAILWAY TRAINING INSTITUTE

CHICAGO

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RAILWAY TRAINING INSTITUTE

The "Railway Library"

The Railway Training Institute was founded, as its name implies, to supply "railway training by railway men for railway men"; to help railway employees fit themselves for better positions and more rapid advancement; to make more proficient and valuable railroaders; to enable railway workers to earn more income, and to co-operate with the railways and assist the employees to the end that better railroading may result.

In the systematic pursuit of these objects, through courses of practical instruction, the Railway Library is used as the basis for individual study. Two of its volumes are especially devoted to a course in Railway Shop Administration; the remainder of the volumes of the Railway Library pertain directly to the work of the various crafts employed in the mechanical departments of American and Canadian railways. Its authors and sponsors have been duly mindful of the fact that these railways are the greatest on earth, and that their construction, operation, and maintenance have gained the admiration of the world and placed them in a class by themselves as national systems of transportation.

The object, therefore, has been to make the Railway Library worthy of the educational cause to which it is devoted—the preservation of the prestige of the railway mechanics of North America by the development of efficiency through knowledge of the theory and practice of the crafts co-ordinated in railway service.

These crafts include the railway machinist, the carman, the boilermaker, air brake man, pipe fitter, sheet metal worker, blacksmith, and electrician, all of whom are highly essential to

the successful care and maintenance of railway equipment. In the Railway Library there are text volumes devoted to the theory and practice of each of these crafts; and the methods of practice dealt with are those of actual and approved railway practice, which is highly specialized and differs in many important respects from that which prevails in ordinary industrial establishments employing similar crafts.

Having a perfect realization of this fact, regarding the unique character of railway mechanical practice, and being aware of the special requirements of railway service, the authors of the Railway Library have sought by every means possible to secure information as to approved practice in railway shops, for the purpose of including it in these textbooks; and they have every reason to believe that the result of their labors will meet with the general approval of railway men, in whose behalf this important work was undertaken.

"Ample and accurate information is the first step toward success," said James J. Hill, the railroad-builder of the American Northwest. That is the thought underlying all the efforts put forth in the preparation of these volumes. To secure ample and accurate information on railway mechanical practice, and then present it in such form that it will be readily assimilable by the student, has been the main object, so that by acquiring such reliable information the studious reader may be given a good start on the road to success.

It may be noted here that the mechanical textbooks of the Railway Library have been compiled and edited under the supervision and with the approval of an Editorial Advisory Board of well-known railway mechanical officials, to whom the Editor-in-Chief desires to return his grateful thanks for their invaluable co-operation and assistance. The names of these gentlemen are set forth on a following page.

The two volumes on Railway Shop Administration are from the capable pen of Mr. Ernest Cordeal, author of "Railroad Operation," etc., a gentleman of long experience in the rehabilitation of railroad properties and the reorganization of mechanical departments. Mr. Cordeal's work speaks for itself, and it

is predicted that it will become a standard authority on the subject of railway supervision.

Special mention should also be made of the fact that a considerable amount of material incorporated in the Railway Library was obtained through the co-operation of officials of several great railways, including the Atchison, Topeka & Santa Fe Ry. System and the Chicago, Burlington & Quincy R. R., to whom a large meed of gratitude is due for their assistance in this educational work. The results of the labors of the educational committees of the Burlington, and the excellent system of apprentice instruction on the Santa Fe have been freely drawn upon in the preparation of this work for general railway benefit.

It remains only to be added that numerous railway men throughout the United States and Canada have greatly aided the work with valuable advice, suggestions, and contributions of material regarding railway mechanical practice. To all of these the most sincere thanks are hereby accorded, since they have helped to make good the slogan of the Railway Training Institute, "railway training by railway men for railway men."

May these volumes of the Railway Library and the courses of individual instruction of which they form the basis and an important part—though only a part—prove the means of starting many a reader on the road of self-help which leads to advancement and the highest form of success in life and railway work.

T. H. R.

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RAILWAY
SHOP ADMINISTRATION

By

ERNEST CORDEAL

“Earth gave her chosen men of strength
(They lived and strove and died for me)
To drive my road a nation’s length
And toss the miles aside for me.”

—*Kipling.*

“No man can attain leadership without paying the price for
it. He must be willing to study.”

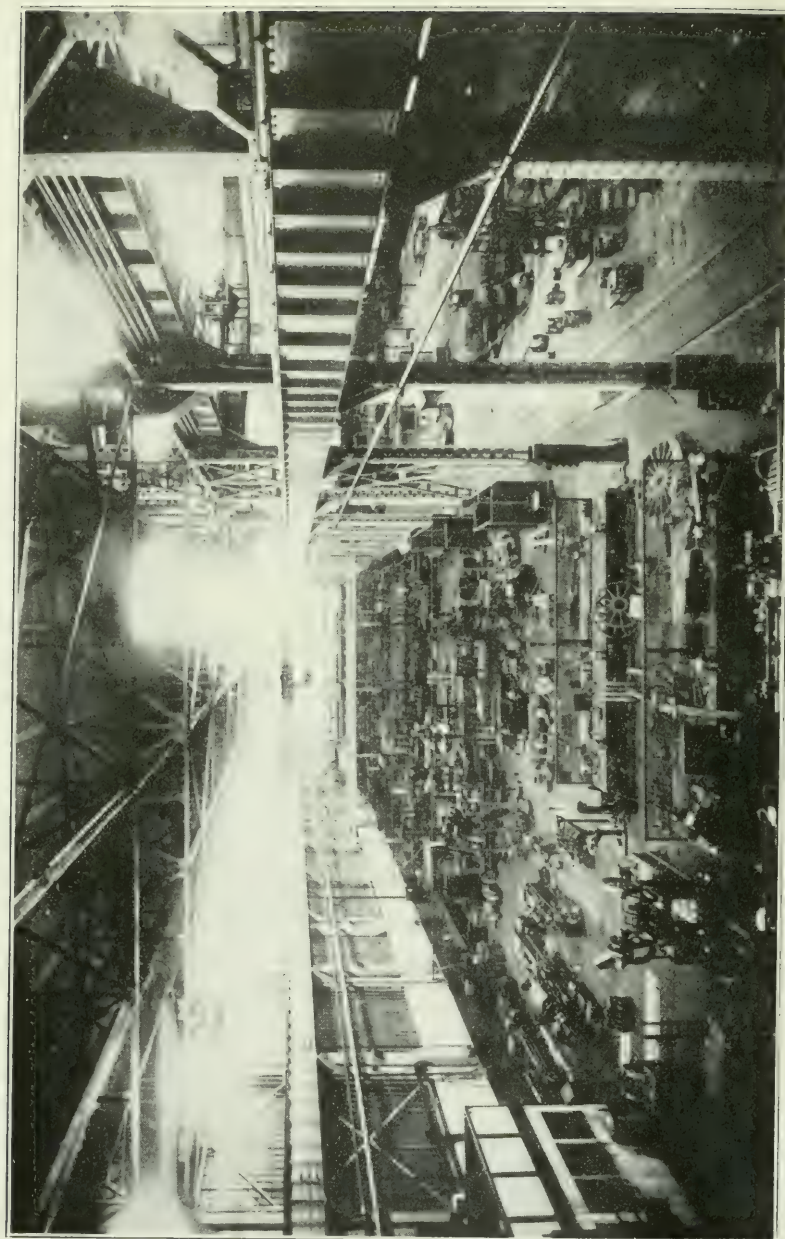
—*General Car Foreman,*
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RAILWAY SHOP ADMINISTRATION

INTRODUCTION

It is axiomatic that the best workmen do not always make the best foremen. Many mechanics of superior ability serve out their lifetime in the ranks while men who are less skilled, and perhaps less energetic, are promoted to positions as Foremen, Master Mechanics, Superintendents of Motive Power, and Presidents of railroads. It is not unusual for individuals so passed over to attribute the greater success of their fellow-workers to luck or pull or mere bluff, but, in truth, the reason is very different.

American industry is the most democratic institution in the world, and American railroads are the most democratic of all the industries. Europeans call us dollar chasers, and, no doubt, we are, in the sense that the men whom we consider successful are those who can so manipulate capital and labor as to produce a profit. And for the very reason that we are dollar chasers, the men who rise in the industrial world must be the men who can deliver the goods. A man may get a position through influence, he may be promoted through pull, a clever tongue may help him rise from the ranks, but nothing but knowledge, ability and energy can keep him in a position above that of a mere workman, and no amount of luck and pull will hold his job for him unless he is successful in co-ordinating capital and labor into profitable production.

The man who has any doubt of the truth of the statement that any railroad man, no matter how humble his present position, may confidently aspire to the highest place in the management, has only to look up the record of the men who now act as Superintendents of Motive Power, General Managers and Presidents of the railroads. Practically every man who occupies

the position of Railroad President today, rose from the ranks. These men started life as call boys, wipers, apprentices, track laborers or clerks, and their opportunities were no greater than those of the thousands of men now occupying similar positions. Where there is one high railroad official who is a college graduate there are ten who have no more than a grammar school education.

There is no denying the advantages of a college education, for those few who are fortunate to be able to spend their young manhood in school, but, on the other hand, there is no reason why the boy who is compelled to go to work at an early age should consider himself handicapped in the race for promotion. On the railroads there are many college graduates working in the shops or on the drafting board, while men with but a few years of schooling are supervising their work. It is particularly true in the railroad field that practical experience counts for more than does theoretical knowledge.

Let it not be thought, however, that the men who rise to high positions on the railroads do so without education. Their days in school may have been few, but their education has progressed from day to day, in the shop or on the road. The man who does not study his own job and that of the man above him is not promoted, or if he is promoted he fails and loses his opportunity. The man who studies while he works is the best educated man in his line because he makes practical daily application of the knowledge which he acquires. The man who does not study may become fairly proficient, in one line of work, but he is little better than a machine; there is no future for him beyond the assurance of a steady job.

But for the man who is constantly acquiring knowledge, not only about the work which he himself is doing, but about that of the men around him and of the foremen over him, there is a straight path to the very top of the industrial ladder. There is no power to hold back the man in the ranks save only the ambition to rise. "Knowledge is power," is not an empty phrase from the mouth of an impractical philosopher, but is a truth which is proven a thousand times every day.

The principal difficulty which has confronted the ambitious worker in the past has been how and where to acquire the knowledge which he needed to fit him for the higher positions in the management. To dig things out for himself was a long and laborious process, and the men who have themselves risen to higher positions are not usually good teachers, even if they have the time to devote to the instruction of their subordinates. It is to fill the need of these ambitious men that this course is written.

The man who aspires to foremanship must know more than merely how to operate machine tools, or how to strip and erect a locomotive, or how to repair a box car. He must understand men and materials. He must know how to select the proper man for the particular job, he must know the properties and values of materials, he must understand the organization of working forces and the proper methods of assembling and preparing materials. And, if he expects to rise from a foremanship to higher positions, he must understand how railroads are organized, and financed and managed.

It is a well-known fact that there are more \$25,000 a year jobs in the industrial world than there are men to fill them. This is true because there are comparatively few men who have educated themselves up to the point where they are worth that amount of money to their employers. While there are occasional periods of unemployment in all of the trades and while wages and hours fluctuate up and down, there is always a persistent and insistent demand for men who are competent to fill the higher positions in the industries and railroads, and the good foreman or manager need never lack profitable employment.

Every man's future is in his own making. Demosthenes stuttered, yet he made himself the greatest orator of all time. Napoleon was an epileptic, but he conquered half the world. Steinmetz was a cripple from birth, yet he was one of the outstanding scientists of our generation. In the face of the thousands of examples of men, gravely handicapped by physical disabilities, who have risen to the very highest places, there

is no reason why any able-bodied man should despair of success in any chosen line of promotion.

In the current phrase, much we hear about Opportunity knocking at the door is bunk. Opportunity is as shy as a country maiden on her first trip to the city. She must be pursued and captured and held. The man who waits for opportunity to ring his doorbell will keep his wife busy putting patches on the seat of his pants, but the man who succeeds will wear out much shoe leather. When there is a position open for a foreman in the shop, no fair goddess named Opportunity goes out and picks her favorite to fill it. On the contrary, some hard-headed executive looks over the human material which is about him and picks out the man who has been handling his own job well and at the same time has been studying to fit himself for the next higher place.

There are no short cuts to success, and the man who spends his time looking for them will end where he started. A man must depend upon his own efforts to rise, but if he is wise, he will accept all of the help which comes his way. Experience is the only reliable teacher, but the man who depends entirely upon his own experience to progress has a long hard road to travel. If every generation had to depend entirely upon its own experience we would still be wearing fig leaves and living on cocoanuts. It is the accumulated experience of thousands of generations which makes our present state of civilization possible.

In the case of an individual, the man who rises to the top is he who profits by the experience of those who have climbed the ladder ahead of him, the man who studies. Put a bunch of boys into a machine shop with no experienced mechanics to instruct them, with no books or courses of instruction to enlighten them as to the operation of the equipment, and they would not turn out a single useful article in a lifetime. Even when men have the advantage of watching the work of those above them, the valuable knowledge which they may so acquire is strictly limited and many things which they do learn are wrong.

Study is no adequate substitute for experience but it is an invaluable aid, and when practice and knowledge are acquired together the combination is a certain force for rapid promotion. The following lessons in supervision are written with the purpose of helping the man in the ranks to rise to foremanship, and of helping the foreman to climb to the higher positions in the management of the railroad. The man who will conscientiously study these lessons, and who will apply the knowledge so acquired to his everyday work in the shop, will be ready when the next higher position becomes vacant, and he need have no fear but that the chance will come when his superior ability will bring him promotion.

It should be understood that the first step up out of the ranks is the most difficult. The man who becomes a foreman and handles his job intelligently and efficiently will find that further promotion comes his way at regular and frequent intervals. The main thing is to get started and then be ready, with knowledge of the job ahead, when the opportunity comes.

Many a competent workman has failed as a foreman, and many a foreman has fallen down as a General Foreman or as a Master Mechanic for the single reason that, while he understood his own work thoroughly, he had little or no knowledge of the job to which he was promoted. Energy and loyalty may gain promotion but only that knowledge of the requirements of the position, which enables a man to perform his duties efficiently, will hold the place. It is too late to learn how to be a foreman after you have been made one. The mistakes made during the period of learning usually prevent further promotion if they do not, in fact, lead to a setback, and a man who has once been tried and failed is not usually given another opportunity.

The text of these books on Supervision is designed for the study of the man in the ranks who hopes to become a foreman, and for the man who, being already a foreman, wishes to go up the line to the higher positions of management. The more knowledge a man has the better he is fitted for his own job and

for the job ahead. The workman or the foreman who understands the work of the General Foreman, the Master Mechanic and the Superintendent of Motive Power and who knows how railroads are financed and managed, will not lack opportunity to put his knowledge to profitable use.

CHAPTER I

THE FOREMAN AND HIS JOB

1. The Relation of the Officer to the Organization.

Our government maintains two great schools, one at West Point and the other at Annapolis, for the purpose of training military and naval officers. In the army the private is merely a unit among hundreds of other units, who does what he is told to do, and is not required to think. But a hundred thousand or a million privates do not make an army. It is the officers, trained in these military and naval schools and the petty officers trained by long experience in the field, who organize these men into companies, and regiments and armies, and who direct their every movement. Without officers a company of men is a mob, with officers it becomes a fighting unit.

The foreman and the Master Mechanic and the Superintendent of Motive Power are the officers, without which the railroad could not operate. The foreman is the lieutenant, the Master Mechanic is the Captain and the Superintendent of Motive Power is the General. But the mechanical department is but one unit in the railroad army, the track department is another, the transportation department is another, and all of these, under their proper officers, must work together to accomplish the work with which they are entrusted, the manufacture of ton miles and passenger miles.

Just as the officers of the army and navy mold men and munitions into a great fighting machine, so the officers of the railroad take men and materials and equipment and form them into an organization for operating trains to carry freight and passengers. Some railroads are efficiently operated, some are not. Some railroads make money, others are always in the hands of receivers because they cannot pay their debts. And the

difference between the good railroad and the poor railroad is usually a matter almost entirely of the quality of supervision.

2. The Factors of Industry.

The three great factors in industry are men, money and management. Men may always be employed in any desired number, money may be raised or borrowed for any legitimate enterprise, but men and money can only be profitably employed in any branch of industry through the agency of efficient management.

The function of the foreman, in the business in which he is employed, is one of the utmost importance. The higher officers originate policies and formulate general plans of operation, but it is the foreman in direct charge of the work who is responsible for the detail performance of the innumerable tasks which must be effectively done in order that the business shall succeed and prosper. The executive officers of the great railroads and industries fail or succeed in ratio to their ability to gather together and hold a staff of competent and loyal subordinate officers.

The foreman is the executive who actually handles the working force, and who carries into effect the plans and orders of those officers who represent the invested capital. He is the connecting link between capital and labor, the very keystone in the industrial arch. When the foreman fails of his full duty neither men nor money are profitably employed and the burden of loss falls equally upon capital and labor.

3. The Basis of Modern Industry.

Industry in its modern form is made possible by the use of accumulated capital. Capital is merely the surplus of past production over past consumption. The uncivilized man lived from hour to hour, hunting for food when he was hungry, seeking shelter when he was cold, with no thought for the day to come. All the progress of the world away from barbarism has resulted from the efforts of men who endeavored to produce more than they currently consumed, so as to create a surplus

which would lighten their future labors and provide them with more than the bare necessities of existence.

Even within the memory of the middle-aged man, the worker was compelled to toil ten or twelve hours a day to provide for himself and family the necessities and the meager luxuries of everyday life. Within a quarter of a century, a mere atom of time in the history of mankind on earth, working hours have been greatly reduced and wages increased, until the laborer of the present day has leisure and resources to enjoy many of the things which were formerly the perquisites only of the very rich.

The worker who drives to the shop in his automobile and who spends his evenings listening to the radio is privileged to do so because labor and capital are more efficiently employed in the present day than at any time in the past. It is effective management which has accomplished all past progress and which will in the future continue to so employ men and money as to further improve standards of living.

4. The Foreman's Place in the Industrial Scheme.

The function of the banker is to collect the accumulated savings of individuals into funds which may be collectively employed in promoting and developing industries. The duty of the board of directors and of the president is to formulate the general plan and to gather equipment and men to accomplish the desired result. The part of the executive officer is to organize the man power into an efficient working force and to so operate the equipment as to produce from the facilities provided a greater amount of value than is represented by the wages and the cost of the materials and the interest on the capital used in the business.

5. The Source of Railroad Revenues.

The railroad's one source of revenue is the charges and fares paid by shippers and travelers. In order to prosper the railroad organization must produce freight ton miles and passenger miles at a cost below the price at which these things can

be sold. In most lines of industry the price at which the commodity produced can be sold is governed by the cost of production and by conditions of competition. Railroad rates are set by government fiat and profit from operating can only result when the management is successful in holding expenses within the limit of revenues. It must appear, then, that efficiency in operation is even more important in the production of transportation than in other lines of industry.

The officers between the grades of foreman and general manager are the ones who are chiefly responsible for operating results, and it is upon their shoulders that the burden of providing profitable employment for capital and labor rests.

6. Necessity for Improved Operating Methods.

The industrial and social progress of the world depends upon a constant decrease in production costs. It is only by reducing the value of labor and capital which goes into a unit of product that the volume of output can be increased and that living conditions can be made easier for all.

There is a constant and insistent demand for the reduction of freight and passenger rates, and with the rate making authority in the hands of a government commission, which must be influenced largely by public sentiment, it is essential that operation be as efficient as possible so that costs may be constantly reduced to meet lowered rates and the constant demand for more and better service.

Every employee and officer of a railroad understands that his own interests are intimately tied up with those of the company for which he works. Wages and salaries can only be increased when the margin between income and outgo is sufficient to justify the added expense. It is, therefore, evident that the workman or the foreman who contributes to the efficiency of operation is increasing his own potential earning power. Under the present Transportation Act, the amount of money which the railroads are permitted to earn upon the invested capital is strictly limited, and the benefits of increased efficiency of operation accrue to the railroad employee and the shipping

and traveling public rather than to the owners of stocks and bonds.

7. The Mechanical Department's Part in Operation.

Locomotives and cars, roadway, yards and station buildings are the equipment with which the railroad earns its revenue. The actual operation of these facilities is the duty of the transportation department, but their maintenance in such condition as renders efficient operation possible rests with the mechanical and maintenance of way departments. It would not be accurate to say that one department of the railroad is more important than another, for it is obvious that all must work together to accomplish the desired results. The best of equipment and the most competent of train and engine men cannot handle trains effectively over bad track. Locomotives and cars in poor condition will offset the best efforts of the operating force. The best of power and rolling stock will only earn dividends when they are loaded with revenue freight and handled over the line with reasonable dispatch.

The office of the mechanical department is to provide power and carrying capacity for the movement of freight and passengers, and the prosperity of the railroad will depend directly upon how well this duty is performed. A locomotive in the shop or on the hospital track, or a box car on the rip track, is a liability and a source of expense, while the same piece of equipment moving over the line is an asset and a revenue earner. The more efficient the mechanical department, the greater the opportunity for efficiency in the transportation department. Given well designed engines and cars, in good condition, there is very little excuse for inefficiency in the operation of trains.

8. The Mechanical Foreman's Responsibility.

In a factory all of the work of production is concentrated within a limited space, the operation of all departments is under the close supervision of the owners or of the president and the works manager. The railroad stretches over hundreds or thousands of miles of territory and the general officers do well if they

make a yearly trip of inspection over all of the lines. It is evident, then, that the responsibility of the railroad foreman is very much greater than that of the man occupying a similar position in the factory.

The mechanical foreman at a main shop point may, to a certain extent, lean upon the general foreman and the shop superintendent for support, but even here the nature of the work is such that each department head must bear his full share of responsibility and authority. In ordinary factory operation the nature and design of the product is fixed and production consists in following a set routine which is outlined by those in authority. In the railroad repair shop no two jobs are entirely alike and more depends upon the individual ability and initiative of the foreman than upon plan and system.

The foreman at the small division point bears an even greater load of responsibility than does his brother of the main shop. The foreman of the roundhouse or rip track away from headquarters has no one to consult with, and no one on whom to shift the blame in case of failure to do the right thing at the right time. But it is in just such positions that the future high executives of the road gain the experience and self-confidence which enables them to rise in the service.

9. The Duties of a Foreman.

Some railroads within the last few years have established employment departments of personal relations, with the idea of lifting a part of the burden from the shoulders of the foreman. But, on the whole, the foreman in the shop, roundhouse or car department is still required to hire his own men, to train them for the particular work in hand and to weed out the incompetents.

The principal duties of the foreman on the average railroad may be listed as follows:

To hire men.

To instruct new men in the proper methods of work.

To maintain discipline.

To plan the work of his department.

To order the necessary materials.

To stand responsible for the quantity of work done.

To maintain the quality of the work.

To render reports to his superiors.

To maintain close and harmonious relations with other departments.

To keep up the shop equipment.

To study costs of performing various operations.

To eliminate wasteful practices.

On the whole the duties of the railroad mechanical foreman are very similar to those of his superiors, the general foreman, the master mechanic, the shop superintendent or the superintendent of motive power. The difference is in degree rather than in kind. The master mechanic handles more men and more equipment; he must devote less time to details and more time to general matters. The same knowledge which makes a good foreman, however, makes a good shop superintendent, superintendent of motive power or general manager.

The mechanical foreman who expects to rise must not be content with a thorough knowledge of his own department. The machine foreman must know a great deal about boiler work, and blacksmith work, and car work before he can become a first class master mechanic. He must also learn a great deal about the management of departments other than his own. If he hopes to move up into any of the higher offices of management he must understand track work, and the operation of trains, the work of the traffic department and the function of the general offices.

10. The Line of Promotion.

It does not make any particular difference where a man starts in the railroad organization. His chances for promotion to the higher positions of management are equally good, whether he begins as a wiper in the roundhouse, a laborer on the track or an apprentice in the shops. For the position of mechanical foreman shop experience is, of course, essential, but the simple fact that a man has never had an opportunity

to serve his time is not an insurmountable obstacle to his rise in the mechanical department. A knowledge of practical mechanics is very valuable, but it is by no means the most essential factor to progress in the railroad organization. The man who knows how to handle men and materials, who is also able to plan and schedule the work of his department, who can understand and will follow instructions, and who can make comprehensive reports covering what he has accomplished need have no fear of finding the way to the higher positions closed to him.

CHAPTER II

THE NEW FOREMAN

11. Getting the Right Angle on the Job.

When a man is first promoted to a foremanship he must pass through a critical period of probation, during which the eyes of the men higher up will be constantly upon him. If he shows aptitude for his new position during the first few weeks the way will become increasingly easy, but if he makes many mistakes his chance may be lost. Two dangers confront the new foreman; one is that he will work too hard, and the other is that he will not work hard enough.

The ambitious man is naturally a hard worker. He has confidence in his own ability to do things, and takes pride in doing them well. Such a man, promoted to the position of foreman, must constantly resist the temptation to take the tools out of the hand of a workman, to show him how the thing should be done. At times it may be necessary for the foreman to take an actual hand in the work, or to demonstrate exactly how a machine should be operated or an erecting job handled, but such cases should be the exception and not the rule.

The foreman should remember always that his principal duty is to supervise the work of the men under him, and this he cannot do if his hands and mind are occupied in the actual performance of a specific task. The work which any one man can accomplish is strictly limited and the men who are of the most value in the world are not those who actually do the most work but rather those who have the ability to get the work out of other men. The new foreman, then, should control his desire to take hold of the work himself, lest while he labors the work of his department as a whole slacks up.

At the other extreme, some workmen conceive the idea that a foremanship is a sort of a rest cure, and that once promoted it is only necessary to put on a white collar as a badge of authority and acquire the habit of wearing out trouser seats instead of shoe soles. The hard worker may get by, but the man who takes a foreman's job for a sinecure is fairly sure of an opportunity to do his resting outside of the shop.

Because a foreman is not expected to wear overalls does not mean that he is not expected to work. When a man moves up from workman to foreman he merely changes from work which is largely physical to harder work which is largely mental. The workman is responsible only for the special task to which he is assigned, the foreman is responsible for all of the work which passes through his department. If a workman fits a driving box improperly, it is the foreman who will be censured. If the proper materials are not on hand when required, it is the fault of the foreman. If an engine is not ready when called the foreman is responsible. It is necessary, therefore, that the foreman be everywhere about his department, know everything that is going on, and be prepared for any emergency.

12. The Development of a Foreman.

When a man steps out of overalls into a foreman's office he is unfortunate, indeed, if the only training he has for the job is his experience as a journeyman. It is a good deal like jumping into twenty feet of water to learn to swim. The man who is ambitious to become a foreman, therefore, should make a study of the duties of that position well in advance of the time when he may expect promotion to come.

Assuming that the new foreman is a first class all-around mechanic, that he knows how all of the operations in his department should be performed, he still has much to learn before he can hope to be graded as a first class foreman. He must first understand how to handle men so as to get out of them the desired quantity and quality of work. He must understand how to order materials and how to get the work through other departments. He must understand the planning of work, so

that engines and cars will be ready at the time required. He must know how to figure costs and how to estimate the relative importance of different classes of work. And, in order intelligently to handle his own department, he must understand how other departments are operated and how all departments are correlated into an efficient machine for the manufacture of transportation.

The properly placed man in a foreman's job will constantly develop through experience and study, and as his knowledge of his position grows so do his chances of further promotion. The position of foreman is probably the most difficult one to fill in all of the railroad organization and the man who develops himself into a good foreman need have little fear of not being able to handle any of the positions above him.

13. Handling Men.

For the newly promoted foreman the handling of his force is frequently the most difficult problem. The foreman must gain the respect of the men under his supervision or else his administration will be a failure. It is a little difficult for the new foreman to break away from the close familiarity which he enjoyed with his fellow workmen, yet too great familiarity with his men would lead to poor discipline. The successful foreman plays no favorites, but treats all of his men alike. Thirty years ago the foreman had to be able to whip any man under him, but those days are gone forever. The ham-fisted boss with more biceps than brains has passed out and in his place has come the man who inspires respect by his knowledge of the work and his fairness in the handling of his men.

It is not necessary that the man who is promoted to foremanship discard all of his old friends and hold himself aloof from his former associates. To do so would, in fact, mark him as a "swell head," a creature which men neither admire nor respect. It is essential, however, that he let no personal feelings of like or dislike enter into his treatment of his men.

Loyalty is one of the cornerstones of organization. In order that a foreman may be successful he must breed loyalty in his

men. If he expects loyalty from those under him he must show loyalty to his superiors and to the company which employs him. The foreman who talks disparagingly of the man above him must expect to be similarly criticized by those under him. Most of the troubles between capital and labor have arisen because men in supervisory positions have misinterpreted the worker to the owner and the owner to the worker. The owners of industry are interested in securing a profit on their investment, the workers wish to secure the maximum wage. But these two aspirations are by no means in conflict. It is not the wages that labor receives which determines the cost of production, but rather the quantity and quality of output per unit of expenditure. The worker in the automobile factory receives higher wages today than at any time in the past, yet the price of cars is constantly decreasing. The answer is that the management has been able to employ men and machines with ever increasing efficiency, and the added profit resulting has been divided between the workers in the factory and the car users.

The new foreman should realize that he has taken upon himself a great burden of responsibility. His own future depends upon how he carries it. He has assumed a place in the management of the employing company and by his conduct he may influence public opinion for or against his employer. In a recent issue of one of the agricultural journals appeared a letter from a farmer who insisted that freight rates should be reduced upon the ground that railroads were inefficiently operated. This man formed his opinion as to the methods of railroad operation by seeing the local section foreman peacefully sleeping each afternoon while his men rested on their shovels.

14. Planning the Work.

One of the first things which the new foreman should learn is to plan his work. To work without a definite plan is to accomplish the minimum amount of work with the maximum of effort. There is nothing complicated about planning. It is

not a mysterious science only understood by engineers and efficiency experts, but merely the application of everyday common sense to the arrangement of the work to be done.

In order to plan the work of his department the foreman must know definitely the kind and amount of work to be done and the order in which it should be turned out. He must know the capacity of his machines and his forces and must see that materials are ordered and on hand well in advance of the time when they will be required.

It is not the purpose to take up the subject of planning here, as that will be left for later chapters. It should be impressed upon the mind of the young foreman, however, that adequate planning of the work is one of the important essentials of management and that the time to start planning is the day he steps up from the ranks.

CHAPTER III

THE OLD FOREMAN

15. The Survival of the Fittest.

Corporations are called soulless and industry is pictured as a ruthless monster which operates without regard to the rights of individuals. But the law of the "survival of the fittest" is nature's law and not man's. Man has done much to mitigate the severity of its application to human life, but all the power of man in the aggregate is not sufficient to repeal the law.

Idealists of all ages have dreamed of a Utopian state in which every man would be the social and economic equal of every other man, but the dream never has and never will be realized. Communism was in existence before the time of Christ, but every experiment along that line has ended in total failure. Russia has found, in a few short years, that the Soviet is worse than the Tsar.

The law of the survival of the fittest governs in industry because it is the only law which permits constant progress. The best men must go to the top, regardless of age or priority, and those who cannot or will not make the effort must satisfy themselves with inferior positions.

In the shop, it is the man who is best fitted for the position above who receives the promotion, and fitness depends upon knowledge more than it does upon experience. It is often the case that the old foreman is passed by younger and less experienced men and that eventually he finds himself working for a boy who served his time under him as an apprentice. When such a thing occurs it is evident that the old foreman has failed to acquire knowledge beyond that necessary to hold his job.

16. Keeping Up with the Times.

High speed machine tools, air motors and hammers, oxy-acetylene and electric welding and numerous other innovations have been introduced into shop practice within our own memory, and every day finds new methods and equipment being introduced. When the air hammer first came into the shop the old time boilermaker refused to believe that rivets could be driven with wind, yet it would be difficult to find a hand-driven rivet today. When the oxy-acetylene torch was introduced a few years ago it met the most persistent and active opposition, but every up-to-date railroad today uses this welding and cutting process and saves thereby many hundreds of thousands of dollars a year.

Shop methods and practices are under constant improvement. The standards of yesterday are forgotten for the better standards of today, tomorrow there will be further changes. The first locomotive of the Erie was equipped with a sail. Only a few years ago the Stephenson link was standard and "monkey motion" was a joke. And while mechanical processes have improved, methods of handling men, of planning work and of administration in all its branches have also changed.

The man who would progress must never stop learning. When a foreman remains on the same job for ten years it is a sure indication that he has neglected his education. The man who constantly studies new methods, who tries out new processes, who strives to understand the problems of the man above him will never be left behind.

17. The Foreman Today and Yesterday.

The foreman's job today is a bigger job than it was yesterday, tomorrow it will be still bigger. Every improvement in equipment, processes and methods brings the necessity for higher quality in supervision. A century ago the foreman was merely a boss worker who directed the activities of a few men of his own trade. Machines were simple and crude and hand work predominated. Today the machine is the governing factor

of production, great sums of money are invested in equipment and overhead is a greater factor of cost than direct labor.

Either a man grows with his job or the job grows away from him. With the increase in the importance of foremanships has come the necessity for better men in foreman's jobs and in the future still better men will be required. The old foreman cannot afford to rest upon laurels won in the past, but must keep pace with the times.

The increase in the production pace, the introduction of automatic and semi-automatic machines, the improvement in methods of management, all create an opportunity for the ambitious man to rise. Mere manual skill is no longer at a premium, it is the man who works his head who will rise above his fellows. The foreman of the present day must study improved production methods, he must learn how to figure costs accurately, he must understand the new processes which are coming into use, he must know the relation of investment to production and he must make a study of modern methods of organization.

18. The Foreman Should Lead.

Someone in the shop must take the initiative in the introduction of improved methods and practices, and the proper man to do so is the foreman. If he does not some official over him, seeing that the department lags, will either change foreman or will take matters out of his hands and make the necessary improvements, taking the credit which the foreman should have gained. The foreman who opposes the introduction of improved methods or looks askance at unfamiliar processes is merely standing in his own light.

The foreman should not wait for higher officials to recommend or to order improvements in his shop, but should be ever on the lookout for methods of increasing his output and reducing its cost. The man who is tied down to the task of supervising the daily work of a department can only keep up with progress in his line by constant study. The man who studies finds use every day for his newly acquired knowledge

in improving the performance of his department. And when the performance of his department constantly improves, his standing in the organization and his prospects for advancement become better.

There is a precept which every ambitious man should remember. It is better to be censured for doing a thing which should not have been done than to be blamed for not doing a thing which should have been done. Some philosopher has said that "the successful man is the man who does things and is sometimes right." Every man makes mistakes; the successful man forgets them and tries again, the failure throws up his hands and quits.

CHAPTER IV

RAILROAD ORGANIZATION

19. The Object of Organization.

Man, even in his most primitive state, realized the importance of organization. Even animals form themselves into herds or flocks. A single man is but a puny atom, but men grouped together under competent leadership have accomplished all of the wonders of modern civilization. The American farmer today works harder for a smaller wage than do men in any other branch of industry, and the sole reason is that he refuses to adequately organize. While workers of all classes, and manufacturers, and bankers, and professional men, and railroad executives are organized into unions and associations for mutual advancement and betterment, the farmer works alone and he has no one but himself to blame for the condition in which he finds himself.

Organizations are formed for the purpose of concentrating and directing the efforts of a group or class of men along lines which will prove to their greatest mutual benefit. Laboring men organize to increase wages and to improve working conditions. Manufacturers organize to stabilize prices and to develop improved methods of production. What no one man or small group of men can do alone, many men working together under competent leadership may easily accomplish.

Rail transportation is an exceedingly complicated branch of industry. Men of hundreds of trades and occupations must be employed and the work of all must be correlated into a harmonious whole. It is only by means of organization that railroads can be constructed and operated and the better the organization the greater the benefit to the workers, to the owners and to the public.

20. *The Three Forms of Organization.*

Railroads are organized in one of three principal forms, although the lines are not closely drawn and most roads do not adhere strictly to any of the theoretical outlines. The line form of organization is the oldest, and many, particularly of the smaller railroads, still use this system. The unit form of organization was devised, within the last generation, with the purpose of overcoming some of the weaknesses of the line form as applied to railroads with great mileage. The unit form, while almost perfect theoretically, developed difficulties in practice which led to the introduction of a third form which is, in fact, merely a compromise between the two older forms.

The third form of organization is usually called the line and staff, and was devised to incorporate the best features of the line and unit forms. Most of the railroads today operate under this modified form of organization, and while it will be improved upon, the general outline will probably stand for some time to come.

21. *What Organization Accomplishes.*

The railroads are owned by thousands of stockholders scattered throughout the country. In only a few cases is a majority of the stock held by a single man or even by a small group of men. Many of the larger railroad systems have stockholders numbering close to one hundred thousand. This being the case, it is necessary that an initial organization be formed to represent and to care for the interests of the stockholders. The authority of the stockholders, or owners, is delegated to a board of directors, elected by them. This board of directors elects a chairman, who becomes the chief of the organization. The chairman of the board of directors is usually a banker or other large business man and not a practical railroad man. His duties have nothing to do with the actual operation of the road, but rather with the purely financial aspects of the business.

The president, who is selected by the board of directors or by its chairman, is the actual operating head of the railroad,

The man who occupies this position is almost always a practical railroad man, and many of the present day presidents have come up from the shops, or the train service, or the track. On many of the larger railroads the president's time is fully occupied in looking after the larger matters of policy and an operating vice president is delegated to look after the actual running of the road.

The chief operating officer, whether he be the president, the operating vice president or the general manager, is the direct head of the operating force and it is to him, either directly or indirectly, that all of the minor officers report.

It must be remembered, that the operating department is only one of the many departments necessary to complete the railroad organization. The traffic department solicits the business, the revenue from which pays expenses. The accounting department keeps track of the income and outgo of money. The purchasing department buys materials and supplies. The legal department attends to the litigation which constantly arises in the conduct of any business.

It is organization which ties all of these and many minor departments together, so that they work harmoniously to achieve the purpose for which the railroad is built and operated. The complexity of the business of manufacturing transportation will be readily understood and the necessity for efficient organization realized. Initially, vast sums of money must be accumulated for investment in right of way, grade, track and structures. Equipment must be purchased and shops built. Large forces of men must be gathered and trained to their various tasks. And, after the road is in full operation, constant detailed supervision must be exercised over a multitude of operations of highly varying character. These are the things which organization accomplishes.

22. The Foreman's Place in the Organization.

In a beehive there are dozens of workers but only one queen. So on the railroad there are thousands of employees but only a few bosses. When a man is promoted out of the ranks of the

workers he is set apart as an individual of superior ability to his fellows. The fact that he is so selected indicates that his superior officers have confidence in him. The position which he is given is far more important than the differential in pay would indicate. He is a man on trial for higher position in the management. It is the foremen and the master mechanics, the trainmasters and the superintendents, the section foremen and the roadmasters who actually operate the railroad, and every man in such a position should realize his own importance. The president and the operating vice president give orders, but it is the men just mentioned who execute them.

The higher officers of the railroad have their principal opportunity to show their ability by the selection of competent assistants and fortunate indeed is the railroad which has as its head a man who can gather about him other men of superior capacity.

The foreman's place in the organization is one of the utmost importance. The best laid plans may go wrong if they are not competently followed out. Orders may be issued with no effect unless they are properly executed. Nor can all of the everyday work of the railroad be covered by general plans, nor can orders be issued covering every contingency. It is therefore up to the foreman to constantly exercise initiative and judgment in the handling of his department. The man who merely obeys such orders as are transmitted to him from his superiors is not handling his job by any means.

The foreman is in constant and intimate touch with certain men and with certain work. He is the only official who is in a position to detect inefficiencies and wastes and it is his duty and his privilege to correct the one and to eliminate the other. The net result of the railroad's operation depends upon the manner in which a multitude of details are handled and the foreman is the man who controls these details.

The foreman's place in the railroad organization is one worthy of the highest respect, and the foreman himself should be the first to show it that respect. He should remember that authority and responsibility have been conferred upon him because of confidence in his ability to carry them.

Line Organization

23. *The Order of Authority.*

In the line form of organization, which is also called the departmental form, each department forms a separate unit under the supervision of a general officer. The general manager has charge of the transportation department and all division superintendents and superintendents of transportation report directly to him. Under the division superintendents are the trainmasters, yardmasters, operators, dispatchers and trainmen.

The superintendent of motive power or mechanical superintendent is in full charge of the mechanical department. Under his authority are all the shops, roundhouses, car repair shops and rip tracks. The master mechanic is his representative on the operating division, and he in turn directs the activities of all the shop, roundhouse and car foremen. Originally the engineers and firemen reported entirely to the master mechanic, but on most railroads at present the engine men are under the division superintendent. On some railroads where the line form of organization is in effect there is a division made between the locomotive and car departments, the car department being under a master car builder. This official, however, usually reports to the superintendent of motive power and the local car foremen are usually under the master mechanic.

The maintenance of way department is headed by a chief engineer who is represented on the divisions by division engineers or roadmasters or both. Bridges and buildings are in charge of a master carpenter.

Each of the other departments has its chief officer, and these heads of departments all report to the president or operating vice president. In this form of organization each department is a separate unit and authority comes down directly from the head to the minor officers.

24. *The Origin of Line Organization.*

The line form of organization is an inheritance from the days when all business was small. Before the big companies

and corporations came into being even the largest business units were not so big but that one man, the owner or the manager, could keep an eye on all of the details of management. The owner or manager directed the selling and the purchasing, he personally supervised construction and operation and his staff consisted merely of foremen and clerks who took their orders directly from him.

It is obvious that in an organization of this form the entire authority and responsibility must rest upon the chief officer. His assistants in authority look to him for orders in all matters, his word is final on all subjects, and so long as orders are obeyed, his the sole responsibility for success or failure. In operating a small store or factory the burden of supervising all of the details is not too much for a single man, but it is apparent that in a business where thousands of men are employed on a variety of work, the task is beyond the capacity of any individual.

As applied to the railroad, the line organization is a survival of the days when one hundred or less miles of line constituted a system, and when one man or a small group of men held a controlling interest. In the present day it may be said that there is no such thing as straight line organization on any railroad, except perhaps on the very smallest. What is called line organization on the railroads is really the line and staff form undeveloped to the point where it deserves that name.

25. Weakness of Line Organization.

Every man, who is above the ordinary, is a specialist. One man may have extraordinary ability as a salesman, another as a mechanic, a third as an organizer, a fourth as a production manager, but never are all of these abilities found in a single individual. The business which is handled by one man, therefore, is always more or less lopsided. Imagine a locomotive built entirely by boilermakers, or by machinists or by blacksmiths. It is just as necessary to have sales, and mechanical, and production, and organization specialists in operating a

business as it is to have all classes of mechanics in the construction of a locomotive.

The principal weakness of the line organization, then, is that no one man has the ability or the capacity to direct all of the activities of a great business. The executive who knows a little about soliciting traffic, a little about conducting transportation, a little about running a mechanical department and a little about track work and is a specialist in one of these lines would be of very little value to a railroad.

A second weakness of line organization as applied to the railroad is that the heads of departments are too far from the scene of action to be able to exert direct supervision. The president of the railroad operating under line organization will have reporting directly to him a general manager, a chief engineer, a superintendent of motive power, an auditor, a traffic manager, and other officials, but these men are all located at headquarters and only make occasional trips over the line. If the straight line system is followed, however, the president is the final authority in any matter pertaining to any department, and the various general officers are in reality merely staff men to whom some authority and responsibility is delegated.

As has been said, very few if any railroads are operated on the straight line plan. What is usually called a line organization should be more correctly called a departmental organization. Each department forms a separate unit, with a general official at its head. These men have full charge of their branch of the business and merely report to the president on matters of general policy. This departmental arrangement gets away from one of the difficulties of the straight line organization in that it places at the head of each section a specialist in the particular line of work assigned to the department.

A final weak point in line organization is that it places too great a burden of responsibility upon certain individuals and does not develop the co-operative spirit which is so essential to the efficient operation of a great business.

26. *Departmental Relations.*

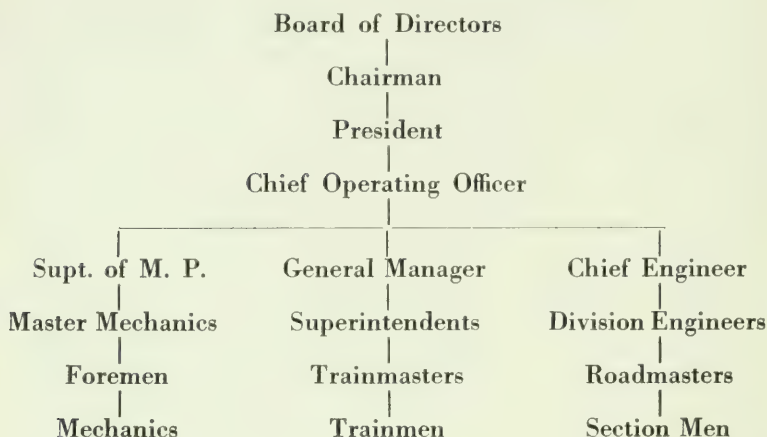
If the railroad is to operate successfully, all of the departments must work together to accomplish the purpose of getting freight and passengers from origin to destination in the least possible time and at the minimum necessary expense. The relation between all departments must, therefore, be close and harmonious.

The track department must do its work in such a way and at such time as to interfere as little as possible with the operation of trains. The mechanical department must have engines and cars ready when they are required to handle trains and must maintain them in such condition that movements will not be interrupted by equipment failures. The traffic department must solicit only such business as may be profitably handled and must endeavor to keep the movement balanced as nearly as possible between east and west movements. The transportation department must outline its schedules and plan its extra train movements so as to give the other departments an opportunity to complete their work in an efficient manner.

No matter what the form of organization there must be co-operation between the officials of the various departments all the way down the line. The superintendent of motive power must co-operate with the general manager, the master mechanic with the division superintendent, the roundhouse foreman with the dispatcher and the trainmaster. This co-operation is a thing which does not always exist in the proper degree where the line form of organization draws too close distinctions between the duties and privileges of departments.

In order that the student may be able to visualize the principle of line organization, the following simple chart is presented. This chart does not represent the complete organization of a railroad, but merely includes the operating departments.

From this outline the student will have no difficulty in constructing for himself a more complicated chart which will represent the complete organization of his railroad.

Chart of Line Organization.**Unit Organization***27. The Theory of the Unit System.*

If a man wanted to move a log, and it was too heavy for him to carry, the logical thing to do would be to saw it into sections of such size as he could handle. So, when organizations became so large that a single man could not adequately supervise them, the idea developed that they should be split up into units of one man size. The unit system, then, is merely a plan for dividing a great organization into a number of smaller organizations, all tied together by a general staff so that all units may operate in harmony.

As applied to the railroad the idea was to make each operating division a unit with the division superintendent as the head and all the mechanical, track and transportation officers as his assistants. The general officers of the railroad also constitute a unit with the chief operating officer as the head and the general mechanical, transportation and maintenance of way officers as his assistants.

The head of each of the division units reports directly to the chief operating officer on all matters, whether pertaining to roadway, equipment or the operation of trains. Theoretically this plan puts a general manager over every two hundred miles of line with full authority to run his division and full responsibility for its performance. The general staff merely outlines policies, establishes standards and follows up the performance of the division units.

The line organization concentrates authority, the unit organization spreads it. The chief operating officer and general manager are relieved of much responsibility under the unit plan and the authority of the division superintendent is correspondingly increased.

28. Details of the Unit Plan.

Under the unit system, master mechanics, trainmasters, division engineers and dispatchers lose their identity and become assistant superintendents. Their duties do not vary greatly from those which they carry under the line plan. Each assistant supervises the work of one department, but all report to the division superintendent instead of to the chief engineer, superintendent of motive power, or other general officer.

In the general unit the superintendent of motive power, the head of the transportation department, the chief engineer and other department heads, are called assistants to the vice president or general manager and are merely staff officers acting in a consulting capacity to the chief operating officer.

Under the straight unit system all orders, to all departments, are issued in the name of the chief operating officer and are directed to the division superintendent. Similarly, all orders within the division unit carry the name and authority of the superintendent and all reports to the general unit originate with him.

The idea, as originally conceived, was to wipe out department lines so that the railroad would operate as a collection of independent units co-operating under the direction of the general unit. The theory was that by this means departmental

friction would be eliminated and definite authority and responsibility would be brought closer to the actual work. The old railroad pastime of "passing the buck" was to be abolished under the unit plan, as when anything went wrong on the division, the superintendent alone would be held responsible.

29. Where the Unit System Fails.

In theory, the unit system is ideal, in practice it has not come up to its press notices. The concentration of authority in the hands of one man on a division seems, at first glance, to provide a solution of many of the difficulties of railroad operation, but, in fact, it sets up other difficulties at least as serious.

In order justly and efficiently to exercise authority the chief must have intimate knowledge of the work of the men he supervises. Superintendents are usually men who have been promoted from trainmasters and trainmen and their knowledge is largely concerned with the operation of trains. Very few superintendents could go into the shop and handle a gang foreman's job or go out and line a piece of track, and when given the authority over the mechanical and track departments they had either to depend entirely upon their assistants who understood the work of these departments or they made many disastrous mistakes.

Some men are big enough to accept counsel from their subordinates and they succeed, others fear to acknowledge ignorance and they invariably fail. The unit system is not generally successful because there are not enough big men to fill the positions as unit heads and small men will not fit. It is entirely possible that at some time in the future the general standard of minor railroad officials will be so raised as to make the operation of the unit plan possible, but for the present it is only possible to put in use some of its best features as modifications of other systems of organization.

30. The Human Term in the Organization Equation.

It is not only opera singers and movie queens who have temperament. Most human beings have it, although most of

us learn, through sore experience, to control it. The unit system necessitates that men be fitted into places in an organization just as parts are fitted into a machine, but men do not so fit or if they do for a time they are subject to spells of temperament which may wreck the machine.

The best system of organization, both for the business and the man, is the one in which each individual is permitted and encouraged to develop along natural lines. This unit organization does not do as it attempts to cast all men in a common mold. One of the original theories of the proponents of the unit plan was that the assistants to the unit heads could be rotated from one department to another, and that by that system all would be developed into all-around men.

It was soon found that a trainmaster put at the head of a shop, or a master mechanic sent out to raise track, was over his head in trouble before he had a chance to get his bearings. Men are quick to discover whether the boss knows his business or not, and when they find that the man over them knows less than they do, it is only human for them to take every advantage of his ignorance. Therefore, while the unit system might operate to educate the division officers in all branches of railroad knowledge, its application in strict accordance with the theory would soon disrupt an organization and create inefficiency.

31. Modifications of the Unit System.

On some railroads a so-called unit organization is in operation but usually the plan is nothing more than line and staff. It was found early in the game that the head of the mechanical department on a division functioned more efficiently when called a master mechanic than when designated as an assistant to the superintendent, and on practically all railroads today, regardless of the form of organization, the various department heads bear the titles which describe their duties.

The best features of the unit plan are maintained on some railroads by having the master mechanic, the division engineer and the roadmaster report to the superintendent in all matters pertaining strictly to operation. This is as it should be. The

superintendent cannot operate trains as efficiently as they should be operated unless he is in a position to tell the master mechanic what power he wants and when he wants it, and to require the track department to keep the rail up to proper standards without undue delay to train movements.

It is not practical, however, to handle all of the details of shop and track procedure through the office of the superintendent where such matters are little understood and on very few roads is the practice followed. The superintendent, being raised in the transportation department, cannot be expected to understand the importance of maintenance details and he can not be blamed for considering that the affairs of his own department are of paramount importance. The transportation man in full charge of mechanical and track departments would not be likely to fully appreciate the constant necessity for the investment of capital in improved shop and maintenance equipment and facilities, and the work of these departments would suffer through stationary or decreased efficiency.

It is for these reasons that the unit system has been modified in practice so that the actual routine of shop and line is left to the supervision of experts in these lines, while mechanical and track officers on the division report to the superintendent only on matters pertaining strictly to operation.

32. The Unit System in Practice.

The condensed chart on a following page presents an outline of the unit system as actually applied in the management of railroads. The difference between this and line organization will be readily seen. In the line plan each department, from top to bottom, is a separate division of the organization, and operation of the road is carried out through co-operation of the division officers in charge of transportation, maintenance of equipment and maintenance of way. Under the unit system, the master mechanic and the division engineer report both to the superintendent and to an assistant to the chief operating officer. These assistants are sometimes called superintendents of motive power and chief engineers, or mechanical superinten-

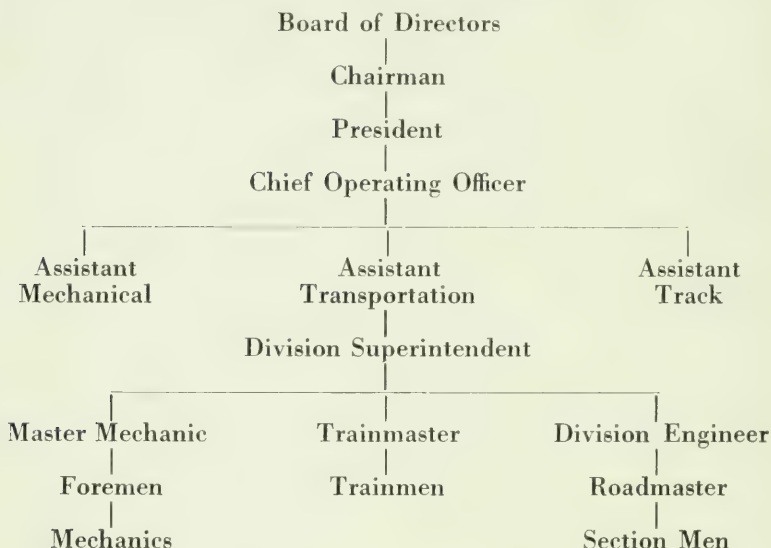
dents and engineers of maintenance of way, and sometimes carry the title of assistants to the vice president, but regardless of title, their duties and responsibilities are approximately the same.

Under this arrangement the superintendent is responsible for the efficient performance of power and rolling stock on his division and for the proper upkeep of his tracks and structures and is, therefore, given certain authority over the mechanical and track departments. For example, he assigns the power, orders engines into or out of service and supervises directly the work of the engine crews. He does not, however, have any authority to prescribe shop methods or to control shop forces. He may say when an engine or a car is to be repaired but not how.

The mechanical and track departments are responsible to the superintendent for keeping the equipment and facilities in first class condition, but they look to their superiors in their own department for all orders pertaining to standards, methods of shop and road procedure, and in all matters of management.

While there is some chance of a conflict of authority under this system of management, it has many advantages over the straight line plan. The superintendent, who is responsible for the performance of his division, is given the authority which he needs over the handling of locomotives and cars at round-houses and repair tracks, while he is not allowed to interfere in the technical problems of management of the mechanical and track departments. In this way the best points of line organization are combined with one superior feature of unit organization.

(See Chart on next page)

Chart of Unit Organization**Line and Staff Organization***33. The Function of the Expert.*

The growth of industrial units has created the necessity for the services of experts in all lines of organization and administration. In the small business there is little or no place for the expert, but in an industry employing thousands of men and representing millions of invested capital, his services are indispensable.

The superintendent of motive power should be a good organizer and should have a thorough general knowledge of all branches of mechanical work, but he cannot be expert in all matters of machine and tool design, in all of the processes by which shop work is performed or in all methods of promoting shop efficiency. And, even if he were a specialist in each of these features, no one man could find the time to handle all

of the details in all of the shops, roundhouses and car departments of a great railroad. It is for these reasons that the expert has been introduced onto the railroads.

The expert is merely a man who knows more about one particular subject than does the average man. One man is an expert in the design of efficient tools, another in the application of the oxy-acetylene welding process, a third in the handling of labor, a fourth in the development of effective shop methods.

The function of the expert in the railroad organization is to develop efficient practices along the line of his specialty, thereby relieving the line officers of all but the duties of straight administration of their departments. Without the staff expert, the development of each individual shop, roundhouse and car department depends entirely upon the technical ability of the men directly in charge, and further upon whether or not the line duties with which they are charged leave them leisure to work out improved methods and devices.

Usually, the master mechanic, shop superintendent, general foreman and department foremen are fully occupied in getting the required output and in handling the working force, so that they have no time or energy left to make a study of the details of methods and processes. The staff expert is burdened with no routine duties and can devote his entire attention to the improvement of detailed processes or to the detection and correction of inefficiencies.

34. Staff Organization.

The staff organization is merely superimposed upon the line or unit organization which actually operates the railroad and does not in any sense replace it. The staff experts are assistants to the line officers and their authority and responsibility is limited within the bounds of their specialty.

The superintendent of motive power may have staff assistants in the form of general boiler inspectors, air brake instructors, apprentice instructors, welding supervisors, engineers of shop methods, mechanical engineers, engineers of tests and supervisors of shop tools. These men are, as it were, merely parts of the

superintendent of motive power. They make investigations and reports or perform certain special duties belonging to his office but for which he personally has no time.

These staff men are assigned to certain specific tasks, such as the standardization of tool design, the development of autogenous welding, the education of apprentices or the maintenance of desired standards of performance. Their authority comes from the superintendent of motive power and their duty is to assist the line officers in the promotion of the efficiency of the department.

35. The Relation of Line and Staff.

There is no question as to the efficacy of the staff system of improving methods of operation and administration, but the results which will be secured in any individual case depend entirely upon the degree of co-operation which exists between the line officers in actual charge of shop work and the specialists who are sent in to assist them. When the staff man confines his activities strictly to matters with which he is charged and refrains from taking things over the head of the local officers, and when the line men accept the assistance of the expert in the proper spirit and do not consider his presence as an infringement of their prerogatives, good results will be obtained.

The effectiveness of a staff organization depends largely upon the personality of the members of the staff. These men should, first, thoroughly understand their business so that their views will command the respect of foremen and workmen. They should be diplomatic rather than dictatorial. Every man of mature years hates to be told things as though he were an apprentice just beginning his time and the staff man who attempts to impress the fact that a thing is so merely because he says it is so will make very little progress.

The relation between line officers and staff officers should be the same as those between a man and his doctor or his lawyer. The line officer must have confidence in the staff man's ability to help him solve his problems, for if he has not, he will gain

no benefit from the service rendered him. All of the officers should bear in mind at all times that whatever improves the conditions on their railroad helps them personally.

If a staff man can introduce better tools or improved methods it will help the master mechanic, or the shop superintendent or the foreman to increase the output of his department or to decrease its cost and for such improvement as results, the local officers will receive their full share of credit.

36. The Foreman and the Staff Man.

Any man who takes time out of his limited leisure to study this course does so because he hopes it will help him to future promotions. The same man should gladly accept all of the help that he can get from other men to increase his store of knowledge and fit him for higher positions in the management. The foreman who co-operates with the competent staff man in the introduction of new and improved methods and practices is acquiring experience which will be invaluable to him later on.

The value of education lies largely in the development of mind capacity. The problems of everyday life cannot be set down and diagrammed and analyzed so that the student may find in books the solution of every situation which will arise. From books or courses of study he may acquire the rudiments and develop the faculty of analysis, but only by practice may he perfect himself in the knowledge gained.

The foreman, then, should take advantage, not only of every opportunity to study the theory of his work, but should also avail himself of every chance to observe the work of other men who have specialized in certain lines and to learn from them all that they have to teach.

37. The Development of Staff Men.

As a rule the staff men on a railroad, except those engaged in the strictly technical branches of the service, are recruited from among the foremen and shop officers who develop special ability along certain lines. The staff, therefore, provides another avenue of promotion for the ambitious foreman.

Such positions as that of tool supervisor, boiler inspector and welding supervisor are almost always filled by workmen or foremen who have shown unusual aptitude along those special lines. The gaining of such a position means more than the possible increase in pay and authority, it means that the man is brought in closer touch with the general officers of the company and that, consequently, he will have a better opportunity to make his abilities known and appreciated.

The foreman should make a careful study of the organization of his railroad so that he may direct his efforts along definite lines. A definite purpose is one of the most important essentials to sure and rapid progress and the man who knows what he wants to do is well on the way toward doing it. Most men have special talent along some particular line and in this age of specialization it pays to develop such ability to the highest possible degree. A man does best the things for which he has a liking and drudgery consists in doing things he neither likes nor has special talent for.

The all-around man, like the mastodon, is a creature of the past. There is too much to be known about any business for one man to be able to master it all in a single lifetime. The ambitious man should concentrate, therefore, upon the line for which he is particularly adapted and should become an expert and an authority in that line. This does not mean that the man who expects to rise far must not have a good general knowledge of all branches of the business in which he is engaged. The operating vice president of a railroad may be an expert in some particular line, and in fact he usually is, but he must also know a great deal about all other lines connected with the business.

The principal advantage of the line and staff form of organization is that it permits the executive to gather about him specialists who supplement his knowledge in the several special branches of operation and enable him to develop the business which he heads along symmetrical lines.

Every mechanic knows that certain properties are required in the materials used in the construction of cars and locomotives.

Firebox steel, for example, must have a certain tensile strength and a certain elasticity. Stronger metal with a lower factor of elongation is inferior for the purpose, as is metal which is more flexible and has less ultimate strength. So it is with organizations. The line form is strong and rigid, while the unit form is flexible but lacks strength. The line and staff form combines strength and flexibility and is, therefore, best fitted for the administration of large industries.

38. The Foreman's Staff.

In the shop the wise foreman will take advantage of the staff principle in working out his own problems. The machine, or erecting, or roundhouse, or car foreman will usually have one or more assistants or gang foremen and he can make best use of these men by employing them in the detailed supervision of certain work for which they have special ability.

The line organization in the shop is constantly occupied in keeping up the output of locomotives and cars. The transportation department is almost constantly calling for more power and more rolling stock and the higher officials have a keen eye on current expenses and are loath to advance money for shop improvements. The duty of the shop organization is to get production and that duty cannot be neglected even for the study of methods which would mean ultimate increase in the capacity of the shop and decrease in the cost of output. It is in this emergency that staff organization comes to the rescue of the line. Shop efficiency may be developed by specialists assigned to specific tasks without interfering with the regular routine.

One assistant assigned to the improvement of tool equipment, another to perfecting the plan of routing the work, another to developing and analyzing costs, will help the shop superintendent or foreman in improving the efficiency of his department and will leave him free to devote his entire time to matters of general administration.

CHAPTER V

FINANCING THE RAILROAD

39. *The Value of Money.*

The fact that money, in itself, has no value is very much easier to understand since the new governments of Germany and Russia have so clearly demonstrated the proposition. Before the war Russian and German money was just as good as American money any place in the world, because behind every ruble or mark was its full value in accumulated property.

After the revolutions, which overthrew the old governments and placed inexperienced men and men with wild economic theories in control, printing presses were started to work day and night turning out money. The theory was one which has been held by many men in many countries, even our own, and it was based upon the erroneous assumption that money is wealth. The soviet leaders in Russia and the heads of the new republic in Germany thought that if there were plenty of money every one would be rich and prosperous. But as the actual amount of money in circulation increased its value decreased until it took a hat full of rubles or marks to buy a cigar.

The actual wealth of Germany and Russia had been decreased during the war and the stamp of the governments on pieces of paper could not give them a value which was not supported by property in the hands of the citizens. The paper money which was placed in circulation, instead of making every one rich, made nearly every one extremely poor and only the few persons who had great stocks of goods, which men must have to live, profited. A laboring man, if he could find work, would receive ten or perhaps a hundred times the wages in money which he received before the war, but the cost of all the things which he must buy had gone up in even a greater proportion, so that all

of his extra wages were consumed in the purchase of the bare necessities of life. Germany and Russia, at least, have learned that money is not wealth.

In the beginnings of civilization there was no wealth, except the latent wealth of nature. A man picked fruit, or dug roots or killed animals for food, but his whole thought was for his present needs and he accumulated nothing for use tomorrow or next year. The primitive man had a hard life. If a late frost killed the fruit buds he went hungry. Unless he was a very good shot with a club or a stone he had difficulty in getting fresh meat. He had to live in a warm climate because he would have frozen or starved in a land where the winters were long and hard.

40. The Accumulation of Wealth.

But man was created with a brain and he soon reasoned, that, in order to make his life easier, he must accumulate in the good seasons the things he would need in the bad years. Then, instead of merely hunting food when he was hungry and crawling into a cave when he was cold, he began to do a little extra work every day. He gathered more food than he needed for the next meal. He built himself a shelter from the weather, into which the wild beasts could not enter, and he saved the hides of the animals which he killed to make a covering for his body.

Now, he had begun to accumulate wealth, and while there was no such thing as money, he could trade his extra supply of cocoanuts to a neighbor for a hide or a war club, or could hire him to work for him. The accumulation of capital, that is a surplus of goods of various kinds over the supply necessary to sustain life from day to day, made possible the growth of industry. Capital, to be sure, accumulated very slowly and many centuries passed before there was enough wealth in the world to form the basis of any large business ventures.

A little repair shop or a corner grocery can be run on a capital of a few hundred dollars, but a great business, like an automobile factory, a steel mill or a railroad requires the

investment of millions of dollars in property, equipment and materials before operation can begin.

The railroads of the United States have been valued by the Interstate Commerce Commission at about twenty-three billion dollars. Even this sum, large as it is, does not represent the actual amount of capital which has been invested, as billions of dollars worth of property and equipment, purchased and used at one time, is no longer in existence. Hundreds of millions of dollars of new capital are required every year to pay for necessary improvements to the railroad property and for new equipment, so that the investment is constantly increasing.

41. What Is a Billion Dollars?

It is difficult even to form an idea of what a billion dollars means. A coal miner digging ten tons of coal a day, valued at five dollars a ton, would have to work twenty million days, or one hundred thousand years of two hundred working days each, to produce coal of a billion dollars' value. The population of the United States is about one hundred and fifteen million, so that the present value of the railroads represents an investment of two hundred dollars for every man, woman and child in the country. These figures may give some idea as to the financial importance of the transportation industry.

It was once rather generally believed that the railroads were owned by a few very rich men who had their offices in Wall Street, and there are still a few men who believe that the railroads are owned and controlled by a small group of bankers. This is very far from the truth. The Pennsylvania has hundreds of thousands of stockholders, and the ownership of most of the other railroads is divided among thousands of investors. On some of the smaller systems a few men may own a controlling interest but, on the whole, the railroads belong to small investors who are scattered all over the land.

42. The Ownership of Railroads.

In order to make clear the problem of railroad financing and to show how the ownership of the transportation companies is

distributed it may be well to describe the nature and the purpose of stocks and bonds and to show how they are issued and sold to investors. When a man buys a house he gets a deed which shows that he is the owner of the property. When he buys an automobile he gets a bill of sale, which is practically the same thing as a deed, and shows that the car belongs to him.

When a railroad is built, no one man has enough money to finance the whole proposition, so that it is necessary to get a number of investors to advance money. This is done by organizing a company or corporation and issuing stock. Each share of stock represents ownership in the property which is purchased. A share of the stock may be any value, but in most companies the par, or nominal value, is one hundred dollars.

In late years a great deal of stock of no par value has been issued but most railroad stock has a definite par value. The par value very rarely represents what the stock is actually worth or what it cost the original investors and on the whole is rather a meaningless term. Regardless of whether or not a par value is set, a share of stock is only worth what it will bring on the market.

A glance at the stock market reports which are published in every city daily very well illustrates this point. Most of the stocks listed have a par value of one hundred dollars but it will be seen that the quotations vary from only a few dollars to several hundred dollars. Among the railroads, the shares of the Union Pacific are at present worth over one hundred and fifty dollars, while those of the M. K. & T. are worth less than forty dollars. Both of these stocks have a par value of one hundred dollars, but the actual value of the one is nearly four times that of the other.

43. The Value of Stocks.

The real or market value of a stock is based upon the earning power of the company behind it, and bears very little relation to the amount of money invested in the business. A railroad built across the Sahara Desert would cost hundreds of millions

of dollars but it would not develop enough traffic to buy sand for the drivers, and the stock in such a company would be worthless because it had no earning power. Instances of stocks having little or no value may be seen in the case of any of our railroads which, failing to make expenses and interest on the debts, are put in the hands of receivers for reorganization. The stock of such a road frequently goes down in value to three or four dollars a share and, if there is any chance that the stockholders may be called upon to pay an assessment, they may even go down to the point where they have no value or where the owners will actually pay to get rid of the stock.

When a railroad company is first organized the investors, at the best, must wait several years before they can expect to receive any dividends. They put their money into the company because they believe that in time it will be a paying investment, but the putting of capital into a new company is always more or less of a speculation. It is said that more money has been spent in digging oil wells than the total value of all the oil which has been taken out of the ground. The millions of investors who have bought oil stock and never received any return will readily believe this statement.

Railroads are usually built with money raised by the sale of stock, but after the roadway is constructed and the equipment purchased there must be a long period during which the road is developing business when the income will not cover expenses, and during this time it is necessary for the company to borrow money to pay for materials and labor. This additional capital is raised by mortgaging the property and borrowing money from other investors.

As in the case of the stock, no one has enough money to make the loans which a railroad requires, so that the investment has to be split up and the money raised from hundreds or thousands of persons. A million dollar mortgage may be divided into a thousand \$1000 parts or into ten thousand \$100 parts. Each one of these parts is called a bond and represents a share in the ownership of the mortgage.

44. The Rights of Money.

According to the theory of investment which has grown up with the development of modern industry, money which has been saved and invested is entitled to a certain return or interest. There are, however, three factors which determine the value of an investment. These factors are safety, yield and convertibility.

Bonds usually sell at higher prices than stocks, that is, a bond which pays five per cent interest is worth more than a stock which pays a five per cent dividend. This is true because the bond, being based upon a mortgage or other evidence of debt, will receive interest so long as the earnings of the company are sufficient to pay it, while the dividends on stocks can only be paid out of earnings which remain after all expenses and interest have been paid. The bonds of a company are, therefore, always a safer investment than the stocks. This does not mean, though, that any bond is better than any stock. The stocks of some well established companies, with earnings well over all expenses and fixed charges, are worth a great deal more than the bonds of other companies whose earnings are not so secure.

The interest rate on bonds is fixed and no matter how prosperous a company may be the bond holders do not profit beyond a regular rate of interest. When earnings are large the stockholders, however, may receive dividends at a very much higher rate than the interest paid on any bond and the value of the stock, in proportion to the amount of money originally invested, may be very much greater than the value of the bonds. A five per cent bond will never yield more than five dollars a year per hundred dollars of money invested, but a stock may pay twenty-five per cent or more. The investors in the original stock of some of the automobile companies have received dividends amounting to two and three hundred per cent a year.

45. Factors Controlling Interest Rates.

The rate of interest paid on bonds depends almost entirely upon the factor of safety. That is, it is the standing of the company behind the mortgage which determines the rate of

interest which it has to pay for borrowed money. A great government like the United States or Great Britain can usually borrow money at an interest rate of two or three per cent because the investor is taking absolutely no chance of losing either his interest or his principal. The South American countries where there is a revolution and a complete change of government every few years, must pay as high as five, six or seven per cent for money and at times they cannot borrow at all.

Exactly the same thing is true of the local individuals who borrow at the local bank. The man who has a reputation for always paying his debts promptly and of saving a part of his income, can always borrow money on his personal note at the legal rate of interest. The man who does not pay his debts and who is known to be extravagant, must give good security for a loan and must pay the highest rate of interest.

CHAPTER VI

FINANCING THE RAILROAD

(*Continued*)

46. *The Stock Market.*

Very few things, or men either for that matter, are either all good or all bad. The stock market is no exception. It is very likely that the stock exchanges have a worse name than they deserve and it is certain that they have a very definite value in our industrial scheme.

It has been seen that in order to finance a railroad, great sums of money must be accumulated and placed at the disposal of the organization which is to construct, equip and operate the line. The gathering together of this money is the business of the banker and he must have a market through which to distribute the stock to the investing public. There must be some place where the seller and buyer can be brought together, and the stock market is this place.

We hear a great deal about the speculation which goes on in the stock and produce markets. The newspapers give much space to corners and to stock manipulation but little is said about the real business of the exchanges, which is to provide a means through which big business ventures may be financed.

Strange as the statement may seem, it is nevertheless true that the stock market has been a large factor in bringing about a more equal distribution of wealth. In order to accumulate wealth the individual must first earn and then save money. But even after money has been saved it is of no use unless it is invested so that it will earn interest for its owner. Some men invest their savings in a business of their own, or in property, but there is only a limited demand for such investment. An

individual business is also more or less of a gamble and a great many more fail than succeed. For the man who has learned a trade, and who has a liking for it, the most safe and profitable thing is to seek to rise in his chosen occupation and to invest his savings in the stocks and bonds of old established and well managed industries.

The stock market provides a place where the man with much or little money may go and shop for an investment. Stocks and bonds of all of the more important companies are listed on these exchanges and any one who wishes to buy or sell may do so by paying a small commission to a broker for making the transaction.

It is only through the agency of such an institution as a stock exchange that those who wish to buy and those who wish to sell stocks and bonds can be brought together. Suppose that there were no grocery stores and that the housewife must go out and hunt each day for provisions to feed her family and you have a picture of what investment conditions would be without the exchanges.

47. Margin Transactions.

Most of the criticism of the stock market centers around the practice of buying and selling stocks on margin. It is entirely true that this practice introduces the possibility of pure gambling into stock transactions but it also facilitates the buying and selling of stocks in a legitimate manner. The margin system, when properly used, is merely the partial payment plan introduced into the making of investments. The man who has only a little capital, may invest in stocks, when they are low, by the payment of ten cents or more on every dollar of value, increasing his equity from time to time as his savings accumulate.

The banks lend him the money, upon the security of the stocks purchased, to cover the amount represented above his actual cash investment and any dividends or interest, or any profit from an increase in the value of the stock purchased goes to the investor.

The banks, under the law, cannot invest the money deposited with them in railroad or industrial stocks, but they may lend the investor money on such securities. It is evident, then, that the margin plan facilitates the financing of industry by making the funds in the hands of the banks available for use through the process of loans to investors.

The margin game is not a safe one for the small investor to play unless he stays very closely to those stocks and bonds which are backed by well established, well managed businesses with a consistent record for the payment of interest and dividends. The stocks of these well established companies fluctuate in value slowly and steadily, following the general trend of business, but seldom jump up and down by many points in a single day as do the stocks of some of the speculative ventures.

The danger in margin playing is for the man who hopes to get rich in a short time and without effort. He may see stock quotations jumping upward or downward in a lively market and read of the enormous winnings of some lucky speculator and imagine that here is his opportunity to make easy money. If he loses at the first venture, he is lucky, for he will probably not try again, but if his first experience should net him a fine profit, he is very likely to lose all he has or can raise.

The newspapers give a great deal of space to the fortunate gambler who comes out ahead of the game, but they say little or nothing about the thousands who are wiped out every year. Nature's law is that a man must work for what he gets and deny himself luxuries in order to save and accumulate and the only safe and sure procedure is to obey the law. In the whole history of investment only a few speculators have acquired great wealth and almost every one of them has lost it before he died.

48. The Stock Market and the Railroad.

For the reason that most railroad stocks are listed on the New York stock exchange many uninformed people think that the railroads are owned by Wall Street. Certain politicians and agitators for government control have fostered this belief for

their own personal ends, but there is no truth in it. The railroads are owned by hundreds of thousands of large and small investors and their bonds are largely in the hands of insurance companies and other large depositories of the money of small investors.

The relation of the stock market to the railroad is merely that of an agent for the distribution of the shares of stock and of the bonds. The securities pass through the exchange on their way between the man who wishes to turn an investment into cash and the one who wishes to turn cash into a profitable investment. If every buyer had to hunt for a seller and every seller for a buyer the cost of making and liquidating investments would be very much greater than it is and the investor would have to foot the bill.

Labor, within the last few years, has very properly begun to aspire to a share in the ownership of the industries in which it is employed. The locomotive engineers have organized banks and through their agency have become large owners of the stocks and bonds of railroads and other industries. This group of men have taken exactly the proper course to acquire a share in ownership and the project has prospered largely. Labor should have a share in ownership and the stock market provides a means by which it can acquire such a share. If the workers, either individually or in groups, would invest their savings in the stocks and bonds of the railroads it would only be a few years until the controlling interest in the capital stock would be in their hands.

49. Wild Cats and Cats and Dogs.

Certain stocks are known around the brokers' offices as "wild cats" or as "cats and dogs" and the wise investor lets them entirely alone. There are not so many of these stocks listed on the exchanges as there were in past years and their absence has raised the general tone of the market. While not many of these questionable stocks are now listed on the exchanges there are plenty of them floating about the country and they are as easy to buy and have no less kick than bootleg liquor.

A wild cat stock is one which represents a pure gamble and cat and dog is one that nobody wants. The stocks of many oil and mining companies belong to this class as do the securities of some of the less important industrial concerns. It is such stocks as these, representing purely speculative ventures, which have been largely instrumental in giving a bad name to brokers and indeed to stock exchanges.

CHAPTER VII

FINANCING THE RAILROAD

(Continued)

50. Construction.

Before a railroad can be put in operation, years of time, millions of money and the labor of many men are required. Right of way must be purchased, surveys must be made, grade must be built, track must be laid, shops and roundhouses and stations must be built, equipment must be purchased and forces of men must be collected and organized. All of this construction work must be financed long in advance of the time when any return can be expected on the investment.

Most of our railroads were built years ago and such lines as are constructed in the future will be largely the work of old established companies which are able to finance the projects by means of their established credit. The procedure of financing a new railroad is, however, interesting and instructive and the same principle applies to the starting of any new business.

When a new railroad is projected it is necessary to interest enough people with money to raise the necessary funds for construction and equipment. This cannot be done usually by offering stock in the open market for the reason that most investors wish to place their money where there is a fair chance of suitable present return on the investment. The promoter of the project must, therefore, interest a few men of great wealth in his proposition to the extent that they will advance the money necessary in the hope that at some future date they may be able to sell out at a profit.

Small investors cannot, will not and should not, invest their money in development projects for several reasons. In starting a

new business it is very necessary that the control be concentrated within a few hands, as otherwise differences of opinion and policy will interrupt the progress of the work. A large number of small investors cannot be induced to put up further money when unforeseen contingencies make the cost of construction greater than the estimates, or when the beginning of operation is delayed. The large investor, who is not dependent upon current income for a living, can afford to wait years for the profit on his investment, or he can afford to lose it if the project proves unprofitable, but the small investor is not willing to take such a chance.

For these reasons most of our railroads were originally built and owned by a comparatively small group of men of great wealth. Some of these men made very large profits on their investment while others lost. Most of the profit which came to these early railroad builders originated in the land grants given to the promoters by federal and state governments and not from the actual operation of the roads. In many cases the railroads which built across the great sparsely settled regions of the West were given each alternate section of land on both sides of their right of way. With the coming of transportation facilities these sections were rapidly colonized and the value of land increased until the gift of the State amounted to an immense sum of money.

The old railroad builders did a great service to the nation by making it possible to develop the vast mineral and agricultural resources of the land and perhaps we should not begrudge them the fortunes which they made. There are, however, no more fortunes to be made in railroad construction in this country and those who invest in such projects in the future must be content with fair profits.

51. Operation.

Even after a railroad is built and equipped there must be a long period of operation before profits begin to accumulate. Traffic must be developed or taken away from existing transportation lines and facilities must be constantly increased to take

care of growing business. Such funds as are needed for the current expenses of operation cannot well be raised by the sale of stock as the money is not to be invested in permanent property. It is, therefore, necessary to borrow funds from other investors upon the security of the property in the possession of the stockholders.

This raising of further funds is accomplished by mortgaging the property and by selling bonds based upon such mortgage. The bondholders of a railroad have a prior right to any earnings of the company over the stockholders and interest must be paid before any money is set aside for dividends.

The railroad which regularly makes more money than is required to pay all of its operating expenses, its taxes and the interest on borrowed money, has little difficulty in borrowing any further money which it may need for extensions, for the purchase of new equipment, or for the improvement of facilities, but the road which does not make money enough to pay the interest on its bonds is in an unfortunate position.

When the owner of a factory, a store or a farm fails to make a profit he can close up the business but the railroad is not so fortunate. It must continue to operate even though it may not make enough money to pay actual expenses. When such is the case, and it has been frequently in the last twenty-five years, the bondholders usually take over the property to protect their interests and the road goes into a receivership.

52. Receiverships.

So far as the man in the ranks is concerned it makes little difference whether a railroad is operated by the owners or by receivers, but to the foreman and to the other officers it makes a great deal of difference. The receiver, who represents the bondholders, is mainly interested in getting the railroad back to the point where its earnings are sufficiently above its expenses so that the interest on the bonds may be paid. In order to do this the receiver will demand of the operating officers the most rigid economy and any money for improvements of new equipment will not be forthcoming.

Occasionally the change in management introduced by the receiver, or an improvement in general business conditions, will permit the railroad to get back on its feet, but more often the property is sold to clear up its debts. When this is done the stockholders suffer the principal burden of loss, although some of the bondholders may also be called upon to relinquish a part of their claims.

When a railroad is sold to satisfy its debts the buyers are usually a group of bankers acting for the holders of the majority of the bonds. After such a sale the road is reorganized. Such a reorganization has nothing to do with the operating end of the business but pertains purely to the financial arrangements by which the funded debt is scaled down to such a point that the earnings of the property are sufficient to cover its expenses and interest charges.

By the scaling down of securities is meant the reduction of their par value or the decreasing of the rate of interest. In many cases the junior bonds, those which are based upon second or third mortgages, are converted into income bonds which draw no interest unless the earnings of the company are sufficient to take care of them in addition to all other expenses.

In some cases in the past reorganizations have been put through which took the railroad entirely away from the stockholders and gave it to the bondholders, but in the present day this is not done. The object of present reorganizations is usually to place the property on a revenue earning basis and large sums of money are frequently advanced by bankers and bondholders to rebuild track, purchase needed equipment and thereby permit improvements in operating efficiency which will enable the road to pay its own way.

53. Classes of Stocks and Bonds.

Not all stocks nor all bonds are the same, nor do the names under which they are offered always tell the whole story. Stock is usually divided into common and preferred, but the latter is not always the best as its name would indicate. Common stock almost always represents the actual ownership of the property

and is usually the last class of security upon which dividends are paid. Preferred stock may represent money actually invested or it may be merely a bonus offered to induce investors to purchase the common stock.

Ordinarily, each share of common stock has a vote in the selection of directors and in the management of the business, but the preferred stock is frequently non-voting. In such cases it bears more resemblance to a debenture bond than to a true stock. Some preferred stocks are given peculiar privileges in the charter of the company, such as standing next after the bonds in any possible division of the assets of the company, being guaranteed as to dividends, or sharing with the common stock in any distribution of income above the regular dividends.

Bonds are divided into a large number of classes. The mortgage bond, which is the most common long-term obligation of the railroads, is a certificate representing part ownership in a mortgage covering more or less of the property of the railroad. These mortgages usually cover certain portions of the right of way and trackage. If they are first mortgages they are known as underlying obligations, and stand first in security of all the railroad's debts. When a railroad is foreclosed and sold it is very seldom that the owners of first mortgage bonds stand any of the loss.

There are many bonds, however, which are based upon second, third or even fourth mortgages and their security depends upon the value of the earning power of the road. It is true of all railroad stocks and bonds that their value depends more upon the earning capacity of the road than upon the actual investment of capital. The assets of the railroad, such as its right of way, tracks, buildings and equipment, once purchased and installed, are of real value only when they are so operated as to show a profit above all items of expenses, taxes and interest.

The debenture bond is in the nature of an unsecured note, except in so far as the prior obligations of the company do not equal the value of the property. A debenture bond of a company which is regularly earning the interest on all of its obligations is a perfectly good investment, but when foreclosure occurs

the holder of the debenture is very likely to lose with the stockholder.

Income bonds have been invented within recent years largely for the purpose of adjusting the indebtedness of a company which has fallen into financial difficulties. The income bond is usually unsecured by any lien on the property, and amounts merely to a personal note without indorsement. Income bonds are of two classes, cumulative and non-cumulative. On either class no interest is paid unless and until the earnings of the railroad are sufficient to take care of all operating expenses, taxes and interest on mortgage and other bonds. The cumulative income bond will draw back interest from the date of issue whenever the earnings of the company are sufficient to make the payments, but the non-cumulative bond draws no interest except in the years in which a sufficient amount of net income remains after the payment of all other current obligations.

Another form of railroad indebtedness is the equipment trust bond. Such securities are usually issued in order to buy new locomotives or cars and are secured by the equipment purchased. Every shop man has seen locomotives on the road bearing a plate showing that the engine is the property of a certain equipment trust, which means in effect that the locomotive has been purchased on the installment plan and will not become the property of the railroad until it is fully paid for.

There are many other forms of railroad stocks and bonds than those mentioned, but the principal classes have been covered and those which remain are only modifications of these. Most railroads also borrow more or less money for short terms, ranging from a few months to a few years. Such obligations are called notes and rarely get out of the hands of the bankers as they do not form an attractive investment for the individual.

CHAPTER VIII

THE EMPLOYEE AND THE STOCKHOLDER

54. Reciprocal Obligations.

It is very seldom that a railroad employee sees, to recognize, a railroad owner, unless as frequently happens, the two are combined in one man. It is none the less important, however, that the two recognize their obligation to each other. The railroad owner puts up the money which makes it possible to construct and operate the railroad, but whether or not his investment proves profitable depends entirely upon the employee.

All the individuals making up the railroad organization are employees whether their title be president or call boy. The president may or may not own stock in the company and the call boy may be a stockholder and have a voice in the selection of the board of directors. Whether or not the railroad is prosperous depends upon this employee organization and every man contributes his share to success or failure.

If the railroad is prosperous the employee has a steady job at good wages and the stockholder receives interest on his investment. If the railroad fails to make money wages are held down, working conditions are bad and employment is uncertain, while the stockholder receives no return on the money he has advanced.

The obligation of the stockholder is to provide funds sufficient for suitably constructing and equipping the railroad and that of the employee is to so handle the facilities provided as to make the investment profitable. If either party fails to perform his full duty, both must suffer.

55. The Foreman's Part.

The foreman is or should be a leader. The men in the ranks will form their opinions and direct their actions to con-

form with what the foreman says and does. So far as the machinist, or the boilermaker, or the car man is concerned the foreman is the company and the man's opinion of the management and of the owners will largely depend upon what he thinks of his foreman.

What the owners or higher officials of the railroad do may not always be right, their decisions may at times be hard to understand, but the foreman should refrain from criticism of the management, as his comment cannot possibly do good and may do a great deal of harm. The foreman should be equally careful not to misrepresent the men to the management. It is frequently said, and it is probably true, that most of the labor trouble has its original cause in the indiscretion of foremen who are in direct charge of the men.

A strike means trouble and loss for the owners of the business, but it means greater trouble and more loss for the men, and the foreman should use his utmost influence to adjust any trouble which may arise, before it has become aggravated to the point where the stoppage of work is effected.

56. The Executive's Viewpoint.

The foreman is an executive and has made the first step toward the higher positions in the management. He has just progressed out of the ranks and is thoroughly familiar with the viewpoint of the men. One of the things which he must learn is the relative position of the employee and the owner so that in the conduct of his department he may balance the rights of the one against the rights of the other.

The foreman who does not uphold his men in any proper demand is not doing his full duty any more than he is when he permits loafing on the job or the waste of valuable materials. The foreman who is unjust in his discipline injures the men under him, hurts his own prospects for promotion and damages the reputation of the management as a whole with the employees. The foreman who permits his men to waste time or materials is dissipating the earnings of the company and is injuring both owners and employees.

The foreman should cultivate a broad viewpoint. He should look upon every matter both from the side of the worker and of the stockholder and his decisions should be just to both. Some foremen get the name of "company men" because, when they rise from the ranks, they lose entirely the viewpoint of the man and see every matter from the side of the boss. Such a man is not a good foreman because he has failed in one of the most important functions of foremanship, that of holding the respect and confidence of the men in his charge so that he may arbitrate between them and those higher in the management who do not so well understand matters as they appeal to the man in the ranks.

57. Industrial Relations in the Future.

Industrial relations are constantly improving, but progress must be along lines of evolution and not revolution. Within the last few years the experience of Russia has taught us that no good can be accomplished by overthrowing an existing system, no matter how bad, only to substitute another plan which has even less merit. The Russian peasant was indeed badly off under the Tsar and the old autocratic industrial system, a system which to us would seem little less than slavery, but he is even in worse position under the tyrannical rule of the communists.

The owners of industry are coming to see that the working man must be given a larger share in the management of the company which employs him in order that his interest and loyalty may be gained and held. Men may be driven to work but they cannot be compelled to work intelligently and efficiently. One interested and loyal worker is worth ten who work because they must.

At the present time in many organizations the workers have been given representation in the management and the movement has only begun. In the future we may expect to see, everywhere, employees taking a full part in making the decisions as to policies and practices which in the past have been made wholly by owners and higher executives. The workers, and particularly the foremen, should prepare for this new

responsibility by studying the problems of management, so that when the time comes they may be able to do their part intelligently.

58. The Position of the Railroads.

The railroads are in a difficult position. The rates which they may charge for the service rendered are definitely set by the Interstate Commerce Commission, and their earnings are limited by the terms of the Transportation Act. It is evident, then, that their prosperity depends entirely upon the efficiency with which they are operated. The public will not permit rates to be advanced, and the public is in command, so that if wage rates are to be increased in the future, if working conditions are to be improved, if more and better equipment is to be provided with which to work, the money required for these desirable betterments must come through increased efficiency in operating methods.

The interests of the owner and the employee are identical to a greater extent on the railroad than in any other industry. In many businesses an increase in efficiency may put more profits into the pockets of the owners without benefitting the workers in the least, but that is hardly possible on the railroad. The amount which may be paid as dividends is strictly limited and any surplus must be otherwise expended or turned into the government. The result of this condition will be that as the efficiency of operation improves the employee will benefit through better wages, better conditions and better facilities with which to work.

CHAPTER IX

THE PUBLIC AND THE RAILROADS

59. Primitive Relations.

The simple relations of the age of the family production unit passed with the establishment of trade and the introduction of specialization into industry. The functions of the capitalist entrepreneur, manager, laborer and consumer can be combined only in the most primitive stages of progress. Those who dream of the socialistic millenium look backward and not forward. Communism is a phenomenon of the first stage of human progress, not of the last. The day of individual or even of family independence passed before the fig leaf gave way to the breech cloth. In any organized civilization it is only through co-operation that all social and industrial factors may be co-ordinated into a harmonious and progressive whole.

60. Law and Business.

For the preservation of the social order, in a world which has never lacked an active class of criminally inclined persons, laws for the control of individual action, and authority for their enforcement, are obviously necessary, until such time, at least, as every good citizen is willing to assume and can be trusted with police powers. It is not so clear, however, that the control of industry, through the agencies of charters and regulation, has in any material degree limited abuses or set up superior standards. It is even possible that the long-continued attempts to legislate morality into business have hindered rather than assisted the eradication of evil practices.

Laws designed to curb profiteering were by no means original with our war congresses, and legislative effort along this line seems to have been just about as effective in the centuries B. C.

as in those A. D. Joseph was Pharaoh's food administrator and Pompey was the Herbert Hoover of the Roman Empire. Attempts by government to regulate the price of bread in Milan during the great plague and famine of the fourteenth century led to mob action which dissipated and destroyed the stocks of grain and flour and aggravated a situation already desperate. Coming down to the early history of America and following it to the present day, we find that an enormous amount of legislation has been enacted, amended, repealed and re-enacted by succeeding congresses, all with the purpose of regulating and directing industry along lines of economic morality, but as yet no satisfactory solution of the chronic difficulties has been evolved.

61. The Transportation Problem.

For some fifty years or more the transportation problem has been one of the important issues which legislators have sought to solve. While innumerable sessions of state and national assemblies have been given over to consideration of this problem, while vast sums of public money have been expended in developing evidence of more or less material nature, while an enormous volume of law has been enacted, all ostensibly aimed at the improvement of the relation between the railroads and the public, it may be said truthfully that the situation has not improved in the slightest particular and it would seem, in fact, that the only effect has been to introduce complications foreign to the original problem and to place a burden of expense upon the taxpayer for which he has absolutely nothing to show.

Without attempting any extended argument upon the possible vices or virtues of the Interstate Commerce Commission or of the numerous state railway commissions, it is pertinent to inquire whether the original proponents of this means of regulating transportation matters can read into the records of the years of active functioning of these bodies any permanent and satisfactory solution of any important question in controversy between the carriers and their patrons.

62. *Valuation.*

A number of years ago, at the instigation of that perennial foe of the railroads and other giant industries, Senator LaFollette, the physical valuation of the property of the carriers was undertaken. The theory behind this move was that the transportation companies were one and all grossly overcapitalized and that, if their value were reduced by eliminating the water from their capitalization, rates might be substantially reduced without depriving the actual capital represented by the properties of a fair return. After years of time and millions of money have been spent by the valuation forces of the government and after the carriers have been put to similar trouble and expense (which expense in the end the public must also pay) it develops that the railroads are not overcapitalized; that, in fact, the cost of present reproduction, which is the figure upon which any other business would wish to earn a fair return, would be substantially above the par value of all outstanding securities.

During the early years of intensive railroad regulation it is true that rates and fares were reduced. It is also true that many burdens were heaped upon the carriers by federal and state authorities, all of which added to the expense of operation and a few of which contributed to better service. The safety appliance laws were well conceived and fairly administered. But the numerous "full crew" and "train length" laws, the car shed measures, the headlight regulations and a thousand and more regulatory and restrictive measures, enacted largely by state legislatures, prevented the development of operating efficiency and the reduction of operating expenses and contributed not at all to the quality of the service or the convenience of the public.

63. *The Railroads in the War.*

At the beginning of the World War the American railroads were on the point of collapse. This statement is not open to dispute. Even the most bitter enemy of the railroads, in the

face of the facts developed before and during government operation of the carriers, would not have the nugacity to deny that a continuation of the policy of starvation and strangulation which had developed to its highest point at the beginning of the war would have destroyed our transportation systems within another decade.

Now this has been the total result of the activities of Congress and of forty-eight state legislatures, assisted by all of the commissions which they have created, over a period of years sufficiently long to have developed any possible virtue in the system of unlimited government regulation. Rates and fares were slightly reduced from the highest level reached in the days before regulation, but they were not decreased to the extent which they could and would have been had interference in matters of operation not prevented the normal development of efficiency. To offset any possible advantage from the decreased rates, the quality of the service had become seriously impaired. The railroads went into the war period with insufficient equipment and facilities to take care of the heavy traffic periods of a normal year and were completely overwhelmed by the volume of tonnage which the exigencies of war and its attendant industrial activity dumped upon them.

Any one who traveled over the country during the time of the heavy movement of men and munitions will easily remember the congested sidings all the way from San Diego to New York and from Duluth to New Orleans and will recall the constant delays in service due to the blockage of the lines by the efforts of the inadequate and overworked equipment to move the business. Any man who was actively engaged in business needs no reminder of the time when it took six weeks to move a car load of materials over a single division or when sixty days was good time for the movement of a shipment of L.C.L. between points in the state. How much was such service worth in comparison with the usual prompt delivery of freight in times when the railroad equipment is adequate to handle the business offered?

64. The Value of Railroad Service.

There are three factors to be considered in determining the value of transportation service. The cost of the service, the quality of the service and the time required to complete the service. Under some circumstances it is conceivable that the cost of the service would be the only or at least the most important consideration. If a man who was both paralyzed and unconscious was making a trip from New York to San Francisco, merely for the purpose of changing his residence, it is possible that the quality of the service and the time required to make the trip would be of very little if any importance. Or, if an edition of the Congressional Record was being conveyed by freight to the various constituencies of the members of Congress, it is possible that any delay in the delivery or any rough handling or damage in transit might be overlooked with equanimity. In almost any other conceivable situation the quality and the punctuality of the service would have a sentimental if not an actual cash value.

65. The Demand of the Public.

The public has always demanded of the carriers increasingly better service both as to time and quality. The traveler wants trains which are luxuriously furnished for his comfort and he insists upon fast time whether he is a commuter or a transcontinental passenger. The shipper demands expeditious handling of his goods and asks for special equipment well maintained to protect his freight in transit. Towns and cities require elaborate terminal facilities, which with their growth become more and more expensive to build and maintain. Good equipment and facilities mean the constant investment of new capital, and speed can only be obtained at a relatively high cost of train operation.

The man who purchases a Pierce Arrow does not complain of the price and he who buys a Ford does not expect superior quality. The same men when purchasing transportation should not contend for Pierce Arrow quality at Ford price. Since the

creation of the Interstate Commerce Commission practically its entire time has been occupied in hearing the complaints of groups of shippers and travelers who demand either reduced rates and fares, improved service, better facilities or some combination of the three. On the whole the Commission has been very fair in its rulings, but the process has been one of attrition. The constant demands of patrons for more service for the same money or for the same service for less money has had the unavoidable effect of slowly but certainly building up the cost of operation while as constantly reducing the price at which it might be sold.

The revenue per ton mile and per passenger mile shows a constant decrease from year to year down until the outbreak of the war. The process of beating down the transportation rates had been so gradual that the public hardly appreciated that any reduction had been made, but the decrease had been sufficient, in connection with the collateral increase in wages and practically all other costs, to bankrupt an important percentage of the country's railroad mileage and to place almost all of the lines upon a non-earning basis.

66. Federal Control.

What the government did to the carriers during the period of federal control was no more and no less than could have been expected. The public does not need to be told what it suffered in the way of impaired service in the face of radically increased rates. The roads themselves were bled white by inefficiency of management before the enactment of the Transportation Act permitted their return to their rightful owners. The increased earnings of the roads under the new rates were dissipated by inefficiency all along the line. The extent to which the inefficiency of men in all ranks of railroad service decreased during federal administration is a fact which cannot be expressed in any conceivable set of figures and can only be appreciated by those who are fully familiar with conditions before and after the war.

The government backed by the railroads had brought the railroads to a condition of impotency at the time of the begin-

ning of the war; it very nearly completed the work of wrecking the transportation systems during its attempt at operation. It is not remarkable that the federal administration, in spite of the great increase in rates and in volume of traffic which brought in enormously increased revenues, failed to keep up the service and permitted the roadway and equipment to depreciate to deplorable condition, nor is it remarkable that those under whose orders this was done do not appreciate the situation which they created and ask for credit instead of blame for their performance.

67. Railroad Management.

Railroad management is a profession of many complications and it could hardly be expected that men trained in politics, mainly, and in the conduct of industry not at all, could step unprepared into the management of a business representing billions of invested dollars and involving the supervision of millions of men in thousands of varying occupations and make a success of the experiment. The time of government administration of the carriers was a nightmare which we can only hope made a sufficiently vivid impression on the minds of the public to prevent its recurrence at any time in the future.

Under the beneficent influence of increased revenues, resulting from the higher rates established during federal control and not yet adjusted back to the old standards, the railroads are at the present moment fairly on the back track to prosperity. There is an immense volume of work of rehabilitation to be done to offset neglected maintenance and improvement. The roads which were in excellent condition at the beginning of the war were badly run down at its end and the much greater number of lines which were not up to standard when the government took hold were little more than junk when it let loose.

68. The Quality of Service.

The quality of the service depends upon two factors, the adequacy in amount and condition of the facilities and equipment, and the efficiency of the working force. A very large

percentage of the total mileage of rail lines in this country should be rebuilt from the right of way up, to make of it the efficient and economical medium of transportation which it should be to contribute its full share to the industrial development of the land. Grades should be reduced and curves eliminated. Ballast should be applied and ties and rails renewed. Thousands of miles of double track should be completed and sidings and terminal tracks everywhere should be extended. Thousands of antiquated locomotives and cars should be scrapped and replaced with equipment of modern design. The physical rehabilitation is a matter entirely of securing revenues sufficient to warrant the enormous expenditures entailed.

The restitution of the old-time efficiency of the personnel is, in a way, a far more difficult matter. A quarter of a century ago every railroad man from the call boy to the general manager took a vital, personal interest in his railroad. A Burlington man would fight to prove that his was a better road than the New York Central. An Orient man might admit that his was not quite so large as the Pennsylvania, but he would not concede that it was not fully as well managed. The spirit of loyalty, that force which makes for victory in war and for progress in peace, has been destroyed on the railroads through the intervention of a third party between the managers and their working forces. Under the old system employer and employee had their frequent disputes and fought them out, not always without force and destruction, but in the end they were settled and with every settlement came a better understanding between the parties and a renewal of loyal co-operation. The old efficiency of the carriers can never be restored so long as every minor question in dispute must be referred to an outside authority whose only possible course is to effect a compromise by granting a part of the demand of the aggrieved without much consideration of the points of equity.

69. *Basic Industries.*

Agriculture and transportation are two great basic industries and any policy which injures them is a bad policy. Any

conditions which impede their healthy development are bad conditions for the country as a whole. At the present moment a critical situation exists in these two vital industries. Agriculture is slowly recovering from the reaction which followed the period of inflated land and product values during the war. If left alone the farmer will work out his problems to a satisfactory conclusion, as he has always done in the past, but danger lies in the recent tendency to attempt to administer political nostrums for this purely industrial ill. The transportation companies have made some slight recovery since they were released from federal control, but the campaign against them, which was interrupted by the war, has been vigorously renewed and unless economic reason can be substituted for political prejudice, in the handling of industrial matters, the carriers are in for another period of senseless oppression which will prevent their proper rehabilitation and expansion.

The railroads are ethically obligated to furnish to the public satisfactory and economical service in the transportation of passengers and freight, but on its side the public is no less obligated to keep the clutching fingers of politics off the industry, so that its managers may have a fair opportunity to work out the plans for improved efficiency of operation which they alone are capable of administering.

Industry owes much to the public but the public owes at least one duty to industry. It should insist that the politician keep his nescient fingers off the details of business and devote his talents to the solution of such problems as the exact permissible alcoholic content of prohibition beverages or the merits of leagues or courts in the preservation of world peace.

CHAPTER X

RAILWAYS AND WATERWAYS

70. Industry and Transportation.

The construction, equipment and operation of transportation ways of whatsoever nature is economically justified only when their existence will assist in the industrial development of the country. Industrial progress waits first upon the means of conveying the products of industry to a suitable market. The best oil well in Oklahoma, the most fertile wheat land in Kansas, the richest coal field in Pennsylvania is valueless until the pipe line, the railway or the waterway is laid from the source of supply to the place of consumption. But, there can be no profit in the creation of transportation facilities unless the volume and the grade of potential production is such that it will carry the transportation charge in addition to the production cost and bring the product to the final market with a margin of profit all along the line.

It is true that transportation agents, and particularly the railroads which were built into undeveloped agricultural regions, have frequently fixed initial rates at a point so low that there has been no direct and immediate profit in the carriage of commodities. But where such has been the case the whole object has been the development of the country to the point where the volume of business would repay the carrier its original losses. By no process of reasoning would it be possible economically to excuse the building of a railway or the development of a waterway into a region where it would be necessary to maintain a preferential and unremunerative rate for an indefinite period in order to permit the fruits of production to compete in the market.

71. Inland Waterways.

The development of our inland waterways is an object greatly to be desired. There are vast resources in our inland states which lie undeveloped for lack of population and means of transportation. It is true that waterways could not reach directly any substantial proportion of this undeveloped region but they could relieve the railways of a part of the burden of low class freight and thereby permit this more flexible transportation agent to assist in the further development of latent resources.

Any controversy between rail and water lines would seem most unreasonable; each carrier has its proper place in the general scheme of transportation and there are well defined factors which will determine, in practically every case, whether development should be by water or land and whether existing traffic should move by boat or rail. The cost of transporting a unit of product is in nearly all cases a factor of importance, but usually the time feature also must be considered. Our complex modern industrial organization demands speed as an integral part of service in the transportation of a very large proportion of the total goods of commerce. The manufacturer must figure as a part of the cost of production the carrying charge on his inventories.

The slower the movement of traffic the greater must be the stock of raw materials and the heavier the investment in inventories. The factory or the foundry can well afford to pay for the prompt movement of raw materials into and finished product out of the plant when by so doing the amount of capital tied up in rough stock and in completed goods is held at a minimum.

72. Rates and Charges.

There is much argument about transportation rates but, like Omar, most of us "come out the same door wherein we went." It is all very well to say that rates should be based upon the cost of the service, or the value of the service, but any study of

transportation matters can not proceed far without developing the fact that the only possible basis for a rate structure is the much maligned standard of "what the traffic will bear." But dispute invariably arises as to what the traffic will bear. The shipper naturally thinks that his business should be conceded a minimum rate but to fix minimum rates on all commodities and to fully satisfy all purchasers of transportation would obviously eliminate any profit from the transportation industry, and when profit is destroyed the business can not long survive.

73. Natural and Artificial Waterways.

The natural waterway, without chance of argument, furnishes the cheapest possible means of transportation and the United States has, beyond doubt, been shortsighted in its failure to make full use of its rivers and lakes in the movement of traffic. There can be no possible justification, however, for the development of artificial waterways to compete with established rail lines except as their presence would lower the cost of transporting or expedite the movement of commodities. And, where the government invests in the development or improvement of waterways the traffic subsequently carried by them should be made to bear the cost. There can be no possible advantage in spending the taxpayer's money in the creation of waterways unless such expenditures are returned to the taxpayer through the process of the payment for such improvements by the traffic which moves over them.

74. Competition.

Some of the proponents of waterway development go to extremes in an endeavor to carry their point. They cite the fact that the railways which parallel the waterways maintain rates on through traffic which are far below the average rates for the country as a whole, as an indication that the rail carriers are resorting to unfair methods in order to prevent the growth of water competition.

In this connection it must be considered that the railway which parallels the waterway operates over water grades and

consequently, by the use of heavy locomotives hauling long, heavy trains, can transport a ton a mile at very much less cost than can the road which crosses the divides into the interior. The Virginian Railway, hauling coal over water grades, averages more than 1,500 net tons to the train and makes a profit on traffic which pays less than one-half cent a ton mile; the Santa Fe, which is as well operated as any road in the world, hauls a varied traffic over a series of divides and mountain ranges averaging 500 net tons to the train mile and receiving a rate of more than one cent a ton mile. The Virginian's normal operating ratio is below sixty per cent, while that of the Santa Fe is near seventy. Is there any system of logic which would defend the contention that the Virginian should charge one cent a ton mile because that rate is necessary for the Santa Fe, or, conversely, that the Santa Fe should be compelled to handle traffic at one-half cent a ton mile because it is possible for the Virginian to make a profit at that rate?

It is further charged against the rail carriers that inland routes make rates on traffic moving in competition with water lines or with other railroads which directly compete with water lines, which approximately meet the water or water grade rates. A railroad company, or any other transportation agent, can afford at times to handle a certain quantity of traffic at a rate which but little more than covers the actual cost of train operation in order to fill out the trains which it must run. No carrier can afford to carry traffic the revenue from which does not cover the actual costs, nor will it do so unless compelled to. When inland railroads meet a water rate and bid for the traffic it is done for one of two reasons; either that railroad does not originate or receive from connecting lines enough volume to fill out the trains which it must run, or its traffic is unbalanced with the volume moving in the direction opposite to that in which the business solicited travels.

It costs very nearly as much to move an empty car as it does to move a loaded car and any lading at any rate which a carrier can secure to fill up its empties moving against the volume of traffic contributes just so much toward paying the expenses

of an otherwise unremunerative movement. Is there any one with a germ of economic judgment who will contend that there is any thing wrong with the principle or that the practice is prejudicial to industry as a whole or in any part?

75. Industry and Freight Rates.

What industry wants is a minimum cost of transportation service. When the volume of traffic is heavily one way the cost of operating empty trains or light engines in the direction opposite to the tonnage must be spread over the revenue freight which moves. Every ton of freight which can be secured to fill up the empty cars, even though it may not pay the total cost of the movement, lessens the burden upon other classes of traffic and operates toward the establishment of minimum charges for all kinds of service.

Again, there is no industry, either agriculture, or mining, or manufacturing, which is not interested in the freight rates on the commodities which it consumes as well as those which it produces. The farmer is benefited by a relatively low rate on farm machinery, or on lumber, or on dry goods to an even greater extent, perhaps, than he profits by a low rate on farm products. As a rule the consumer pays the freight. When, therefore, a grain belt road puts in effect a comparatively low rate covering the movement of inbound commodities in an attempt to balance a heavy grain movement outbound the inhabitants of its territory profit directly by the reduced cost of the goods which they buy and indirectly by the possibility of a reduction of all rates because of the added revenue received by the carrier.

The talk of discriminatory rates is usually based upon illy supported and biased opinion. If individual rates were based upon the cost of the service most of the Middle West would be burning buffalo chips for fuel as it did less than half a century ago and coal would be more of a luxury than grape fruit. Why is land in western Nebraska which will raise hundreds of bushels of corn worth less than half as much as Illinois land which is no more productive? Simply and solely because

Nebraska is farther from the market and land values must adjust themselves to the difference in the cost of transportation.

76. The Need For More Transportation Facilities.

Every normal year the railroads are congested at certain periods and industry as a whole is thereby slowed up. That such is the fact can but indicate that present transportation facilities are inadequate and that additional means of carriage should be provided. Whether such added facilities should take the form of waterways, or railways, or highways should be determined in each instance by the relative value and cost of the service which would be created.

No misconceptions, however, should be allowed to enter into the calculations. The cost of waterway service over any particular course must be figured to include the proper capital charge set up through the original investment necessary to open the way to traffic and also the cost of maintaining the route. There is no possible justification for using government money in the construction of a waterway the chargeable rate upon the traffic of which will not carry the direct cost of the service and the proper proportion of the cost of construction and maintenance.

77. The Rights of the Taxpayer.

It has been an all-too-prevalent practice in this country to burden the taxpayer in order that some class of the population or some section of the country might receive benefits. The land grants given to the railroads in the early days established a bad precedent, but when a thing is known to be bad it should cease to be used as a precedent. Let it be remembered also that while the railroads profited temporarily because of the uncalled-for munificence of the government they have since gone through the fire in reparation. The proponents of waterway development should profit by the experience of the railways and in outlining their plans should take into consideration the fact that government favors are as fleeting as the politician's promises, that money advanced by one administration may be used by the next as a club to confiscate profits.

The grain belt farmer, at the instigation of government agencies and in furtherance of the war policy, turned away from the practice of diversification, which for years had been under development, and went back to "high grading" the land by the almost exclusive culture of grain. With the end of the war and the consequent decrease in the demand for our breadstuffs, the farmer found himself with a surplus of grain products the market price of which was not sufficient to cover the average cost of production. The grain farmer has been placed, beyond question, in an uncomfortable position, but neither the reduction of rail rates nor the development of waterways provides a solution of his difficulties.

78. The Farmer and the Freight Rate.

Should the freight rate on wheat be reduced by fifty per cent, every cent of the decrease would come off the price of the grain at the market and not one dollar would go into the pocket of the farmer. Should the rate from one particular section be reduced while other rates were maintained there would be a temporary increase in the profit to the producer, but land values would rapidly adjust themselves to the reduced cost of transportation, so that the higher profit would be consumed in the increased cost of ownership. There is no legislative power which can repeal or amend the law of supply and demand. The farmer overproduced wheat and regardless of any measures which government may take the farmer must take his loss until the balance of production and consumption is restored. At the instigation of those who hold the tariff to be omnipotent the President exercised the power vested in him to increase the duty on wheat and the market paid no more attention to his action than if he had played a game of golf. The Interstate Commerce Commission might declare that wheat should move free without having any greater effect upon the fortunes of the farmer.

There is no valid argument against the desirability of a general reduction of transportation charges, as there is no argument against the reduction of production costs in any line. All material progress is based upon a reduction in production costs.

Every grain farmer has a gang plow and a header, or a binder, or a combine, because the manufacturers of farm machinery have so perfected their processes that the price of such equipment has been brought within his reach. Nearly every rural family in the West owns an automobile because the manufacturer of automotive vehicles has reduced his costs of production to the point where the erstwhile luxury has been brought to the basis of a necessity.

79. Transportation and Production Costs.

Transportation is an integral factor of production and every reduction in the charge for such service must operate as an aid in increasing the volume and reducing the cost of all commodities which move into the market. But, transportation charges must only be reduced as transportation costs are lessened. The price of automobiles, or of farm machinery, or of textiles is reduced as the result of the perfection of methods in their production which permit lowered costs of fabrication. Should the price of automobiles be set by government fiat at a figure which left no profit in their manufacture, all of us would have to get out the old horse and buggy or walk.

There is not the slightest doubt but that transportation rates generally can be reduced to a material extent within the period of a few years if transportation men are let alone in the development of more efficient traffic highways and in the introduction of more economical methods of operation, and if the tax upon capital invested in useful industries is so reduced that money can be secured to finance needed improvements.

80. America's Transportation Rates.

The United States has the lowest transportation rates of any nation in the world and to that fact, and to that fact solely, may be attributed the marvelous development of the country. South America has agricultural and mineral resources paralleling ours and the only reason that she does not rival us in wealth and production is that she has not the transportation facilities necessary to the development of her inland territories.

The fact that the United States holds a dominating position in the industrial world should by no means be allowed to lessen our efforts for further advancement. Our position is secure only so long as we maintain it. Our ascendancy might be immeasurably greater at the present moment if the governmental policy of the past had not prevented the perpetuation of the marine supremacy which we enjoyed in the days of the clipper ship. With a merchant marine of contemptible proportions with relation to our world commerce, we cannot hope to occupy the place to which our wealth and our capacity for production entitles us. We should have the greatest merchant marine in the world and as soon as the throttling hands of politics are removed from the industry of ocean transportation we will have it. Internal development must wait upon the creation of foreign markets to take our surplus production, and so long as our goods move in foreign bottoms and are handled by foreign agents and financed by foreign bankers at destination we cannot hope to enjoy the full profits of our industry nor to reach the highest stage of industrial progress.

Within the nation, under any conditions and particularly if our merchant marine is permitted to grow and prosper, the demand for more, better, and cheaper transportation must become increasingly insistent. Railway lines and branches should be extended into the undeveloped inland regions where the exploitation of rich resources waits upon means of carriage. Existing rail lines should be double-tracked and provided with terminals of increased capacity and with equipment of improved capacity and efficiency. Every practical waterway should be developed and improved to co-operate with the rail lines in the cheap and expeditious movement of traffic.

81. The Proper Viewpoint.

In the development of transportation facilities there should be only one viewpoint from which all projects would be judged. If the development of a waterway would permit better transportation service to be rendered at the same cost or the same service at less cost or if it would establish a service where none

now exists and where latent resources justify its establishment then the waterway should be developed. But if a proposed waterway must be subsidized, through the expenditure of large sums of public money which cannot be returned to the treasury through tolls or other imposts upon the traffic, so that it may compete with existing transportation lines, then its construction is not justified. If a watergrade railway built in the river valley can transport freight at a lesser cost, when all items of capital charge and maintenance are included on both sides, than can the watercourse when developed, then there is no possible process of reasoning by which the conclusion may be reached that the waterway should be developed at the expense of the taxpayer and that the railroad should be compelled to raise its rates so that steamers or barge lines may compete for its business.

Let us get away from petty prejudices and from the consideration of the interests of any small group or section in our analysis of transportation problems. Let every proposition stand on its own merits. Let the determining factor be the necessity for and the economy of the proposed facility, not in the development of any particular port or market center but in the advancement of the nation's industrial life.

CHAPTER XI

RAILROAD CONSTRUCTION

82. Why Railroads Are Built.

Nature furnishes the resources which are necessary to life and to the development of civilization, but it is left to man to develop these resources. Within the memory of our fathers, life was a very much harder proposition than it is today. They worked long hours in field, or store, or mine, or factory and the luxuries which they enjoyed are not equal to our necessities.

Their principal need was for transportation. The ox team, the canal boat and the sailing vessel served a very good purpose in their time, but the development of modern industrial and social standards waited upon swifter, surer and cheaper means of transportation. Without the railroads, the population of the United States would, of necessity, be concentrated, as it was only a few decades ago, along the sea coast, the great lakes and the navigable rivers, and the great inland states, which contain the greater share of the nation's wealth, would be valueless.

With the invention of the steam engine and the iron rail a means was provided for bringing transportation facilities to the resources which could not be reached by waterways. The great mineral, agricultural and industrial wealth which stood latent in the inland states became a valuable possession of man only when iron rails were laid across the continent. It is to the great railroad builders of a past generation that we owe the development of this great nation.

A farmer with a thousand bushels of wheat a hundred miles from a railroad is no better off than if he had no wheat. The owner of a coal mine ten miles from transportation cannot afford to develop his claim. Transportation adds what the economists call "place value" to all the products of the earth and of

industry. Iron in the mine is worth nothing unless there are facilities by which it may be carried to the smelters for melting into pig, to the mills for rolling into billets and sheets and from the mills to the place where it is required for construction.

Railroads are built, then, in order to destroy the distance between producer and consumer, to permit the development of natural resources, and to so cheapen production and distribution as to place the products of one section at the disposal of all other sections.

83. Preliminary Surveys.

When it has been decided that transportation facilities are needed in a certain section and when it is apparent that the business which may be developed will eventually justify the investment, the first step is the making of a preliminary survey to determine the best route. In determining the best route for a new railroad a number of factors must be taken into consideration. The road must tap the natural gathering and distributing points in its territory, but it must also be laid out so as to entail the least possible expense for construction. Old established roads, with a heavy volume of traffic, can afford to spend millions in digging tunnels, straightening curves, reducing grades, laying ballast and heavy steel, in order to cut a fraction of a mill from the cost of hauling a ton of freight one mile, but the new road can make no such expenditures.

The preliminary survey, then, must search out the easiest route so that the road bed may be constructed at the minimum cost. This is no simple task, particularly when there are hills and mountains to be crossed and rivers to be bridged. The engineers who made the preliminary surveys for the great western railroads rode horseback for weeks and months over uninhabited country, suffering hardships which we in this day cannot realize.

84. Location.

The preliminary surveying parties merely trace out in the roughest possible way the route which the road is to follow.

Coming after them the location engineers with transit and level mark out definitely the line which the grade is to follow. These location parties make maps and profiles of the line, determining where cuts and fills, and curves and tangents are to be. When their plans are completed it is possible to estimate what the cost of the line will be, how many yards of dirt must be moved, how many bridges constructed and how many miles of steel laid.

Very often the location engineers find that the route laid out is impractical, that grades and curves cannot be kept within the limit, or that insurmountable construction difficulties exist. When this is the case new preliminary surveys must be made and the whole ground gone over again. One of the great western railroads got their survey to the top of a range of mountains only to find that they could not get down on the other side. The best of their engineers studied the problem for weeks and might have given up and gone back to look for another pass through the mountains had not an axman in the party conceived the idea of building a loop which would let the line down into the valley without exceeding the limits of grade.

85. *Construction.*

After the location has been made the real work begins. Grading crews must be assembled and contracts let, materials collected and transported to the point of use, engineering construction parties sent out to cross-section the line and to place grade stakes. In the present day most of the work of construction is done with power machinery, but when the great railroads were built it was men and horses who moved the dirt and the sand and the rock. Even the Fresno and the wheeled scraper are comparatively recent developments and most of the work on the early railroads was with a team of horses and a slip, with one man on the reins and another on the handles.

The details of how railroads were built in the past, while they may be of interest, can be of little value to the railroad man of the present. If financial conditions are favorable, there may be many miles of railroad built within the next quarter of

a century, as there are still vast territories within the United States which cannot be fully developed until the rail lines are extended. These roads will be built with modern power machinery at a fraction of the cost and with a fraction of the labor which went into the construction of the existing lines. The man and the horse will be replaced by the steam shovel and the grader, tunnels will be bored with air drills and high explosives, bridges will be constructed of concrete and steel, but while the labor of man will be minimized there will be no less call for his mind in the direction of the work. The railroad executive of the future must know the principles of railroad construction no less thoroughly than did his predecessors.

CHAPTER XII

RAILROAD OPERATION

86. Principles.

Railroads are operated for the purpose of transporting freight and passengers from one place to another. All of the departments of the railroad, whatever their special line of work may be, exist for this single purpose and the efficiency of operation as a whole depends upon how well all co-operate toward this final end. It is the business of the mechanical department to repair locomotives and cars and of the maintenance of way department to keep up the track and structures, but all of the work which they do is for the single purpose of making it possible to operate trains. This viewpoint should not be lost sight of by the man in any department.

The prosperity of the railroad depends upon its success in keeping expenses within revenues by a sufficient margin to allow for interest on its indebtedness and for some investment of surplus in improved facilities. The railroad can only prosper when it is efficiently operated, and it can only be efficiently operated when every department does its full share.

The mechanical department is not a detached industrial unit with a business of its own, but is a very essential factor in the total scheme of transportation. The mechanical executive is not merely a master mechanic or shop foreman, but is one of the important officers of a company which is in the business of manufacturing transportation and of selling it to the public. It is from this angle that the foreman should view his job.

87. Essentials of Operation.

In order that a railroad may operate there must be suitable roadway and track, power and rolling stock and an organization

to run the trains, operate the locomotives and keep the track and equipment in repair.

The efficient operation of trains depends upon a number of factors among which are the kind and condition of track, the design and condition of motive power and equipment and the method of train operation. The cost of hauling a ton of freight one mile is influenced by the percentage of grade and curve of the line, by the tractive power of the locomotives and by the ratio which is maintained between potential and actual train loads.

A locomotive is designed to haul a certain number of tons over a line with a given controlling grade, but this theoretical efficiency is seldom realized. If the track is in poor condition the rating of the locomotive must be reduced. If the power is not kept up to standard, the engines will not pull the full tonnage for which they were designed. If cars are not loaded to capacity, the locomotive may haul its full rated tonnage without earning the revenue which it should. When empty cars are back hauled over the road, a part of the potential earning power of the equipment is wasted.

It is very evident, then, that efficient operation means the co-operation of all departments in getting out of the equipment and facilities the maximum amount of work with the minimum amount of expense.

The pay of engine and train men is the same whether their train consists of one hundred tons of light equipment or a thousand tons of revenue freight. It takes almost as much fuel to handle a light train as it does one with full tonnage, and repair charges on equipment depend more nearly upon miles run than upon load hauled.

Proper loading of trains and cars is the duty of the transportation department, but the mechanical foreman who expects to rise to higher executive positions must understand the work of departments other than his own or his usefulness will be definitely limited and his rise will be stopped short of the point where knowledge of things other than those having a strictly mechanical bearing is necessary.

It is a simple problem in mathematics to figure the tonnage which a certain engine should handle over a given section of line but it is an entirely different and much more difficult matter to line up the traffic to be handled so that it moves in proper sequence, with the necessary dispatch.

88. Train and Car Loading.

Cars are built to carry a certain maximum load and the nearer they are loaded to this capacity the more easy it is to make train operation profitable. A train of forty-ton capacity cars loaded to one-half their capacity pulls nearly as hard as a similar train with every car full loaded, but the revenue from the operation of the train is split in two.

During recent years many of the railroads have conducted campaigns to encourage the better loading of cars both by employees and by shippers and some improvement has been made. There is still much to be done along this line and the railroad executive of the future cannot afford to overlook this important feature of operating efficiency. Railroad employees in all departments should do their full part toward increasing the average car load.

Station agents and platform foremen should watch the loading of L. C. L. and peddler cars so as to secure the maximum possible load. Storekeepers should see that shipments of company material are loaded as nearly as possible to car capacity. Mechanical and track foremen who have occasion to load company material or scrap should see that cars are given the allowable ten per cent overload. It costs exactly as much to haul a car of company material as it does a car of revenue freight and there is no possible excuse for loading down trains with light loaded cars of deadhead freight.

The proper loading of trains is mainly in the hands of the dispatcher, under the supervision of the train master and the superintendent, but he cannot do his part unless he has the full co-operation of the maintenance departments. A locomotive with leaking seams or flues, with dirty boiler, with pounding brasses or with ill-fitted packing, cannot haul its full rated

tonnage and get over the division in schedule time. The power of the locomotive is dissipated when it is required to operate over track which is not properly lined and surfaced.

Train loading, then, is not by any means entirely the business of the transportation department. The dispatcher who attempts to load the power to its rating regardless of its condition and the condition of the track will very soon be in serious trouble. A single engine or car failure frequently costs thousands of dollars through the consequent delay to all of the traffic on the division. Tonnage records can only be made when the power is in first-class condition and when track conditions permit it to operate at full capacity.

89. Operating Expenses.

Operating expenses are divided under four principal heads, traffic, transportation, maintenance of way and maintenance of equipment. The greatest expense of the railroad is included under the transportation head, as to these accounts are charged all of the wages of train and engine crews, and of station and yard men, fuel and supplies for locomotives and all of the other items which pertain strictly to the handling of the traffic.

Traffic expenses are small as compared with the other general divisions and include only the charges incident to the solicitation of business.

Maintenance of way and maintenance of equipment expenses run about equal in total amount, varying somewhat with the individual railroad and with the year.

Maintenance of way expenses include the wages of all men employed in keeping up track, bridges and structures and all of the cost of materials required to keep the roadway and buildings in condition.

Maintenance of equipment expenses include all wages paid to shop and roundhouse men, except those occupied in handling power at roundhouses who are charged to the transportation accounts, and of car men, except train inspectors and oilers, and also the cost of all materials required to repair locomotives and cars and to keep up shop equipment.

Under these four divisions of expense are charged out all of the sums which are expended by the railroad in actual operation. The relation between the total amount spent for operation and the total revenue resulting from the transportation of freight and passengers is called the operating ratio, and this is the figure which indicates the efficiency of the organization.

It is not fair to compare the operating ratio of one railroad with that of another and to assert that the road with a ratio of 60% is better operated than the one with a ratio of 70%. There are a great many conditions which control the relation between revenues and expenses and not all of them can be influenced by the operating organization. What the management of a railroad constantly strives to do is to improve its operating ratio over the record of past years, and when this is done it is a sure indication of increased efficiency in operation.

CHAPTER XIII

RAILROAD POLICIES

90. *What is Policy?*

There is a great deal said about the policy of the railroad, and about the responsibility of the foreman for the carrying out of the policy and for the interpretation of the policy to the men under his supervision, but it is not always made clear just what such policy is, or why certain lines of action are followed.

It is not always easy, even for the higher officers in the management, certainly to define the policy of the company. Unfortunately, not all railroads have what might be called a settled policy, and on some of those which do, the real facts do not get down to the man on the job. It is not remarkable, then, that many foremen and other executives find themselves somewhat at a loss when they are told that a part of their duty is to support the policy of the railroad and to see that the men under them understand the general objects of operation and comprehend the reasons for the measures taken to carry them out.

In order that a man may work intelligently it is very necessary that he should understand what he is expected to do and why he is expected to do it. Co-operation within an organization can only be based upon general knowledge of, and confidence in, the directing policy. If the policy of the railroad is not definitely outlined, the formation of a comprehensive plan of operation should be the first step taken by the management to secure the hearty, loyal co-operation of the force all down the line.

The problem of deciding upon the general policy of the railroad is a matter for the consideration of the higher officials, but they can and should get able assistance from the men in the

ranks and from the minor officers, particularly in those matters which pertain to the management of the working forces and to the actual details of operation.

Policy, in the sense in which it is here used, means merely a plan of action. The higher officials of the railroad are charged by the board of directors, who represent the stockholders, with the responsibility for securing certain results, and the plan by which they expect to secure such results is the policy of the railroad.

91. The General Policy.

The object in operating a railroad is always the same, to secure a profit on the investment, and unless that object is attained a railroad or any other business cannot prosper, and when the business is not successful the employees of the business will suffer with the owners. While the object of operation is always the same, the policies by which the attempt is made to accomplish this purpose vary widely.

On some railroads the endeavor of the management is to constantly increase the volume of business, by extending branch lines, by making traffic agreements with other lines, by developing the industries along its own lines, and by perfecting its service to such an extent as to attract business from competing roads. On other railroads the main objective is to hold the traffic already enjoyed and to handle it as well and as economically as possible.

The general policy of the railroad will be influenced by the personal makeup of the men in charge and by the financial ability of the road to carry out programs of extension and improvement. Every railroad manager would like to increase the volume of business handled by his road, but not all of them are able to do so. The natural resources of the country served by the railroad, often place a definite limit upon the volume of traffic which can be originated and upon the imports of goods into the territory. When this limit has been reached the further growth of transportation business must follow the slow development of the industries.

The business which a railroad may hope to secure is also limited by the amount and quality of competition and by the capacity of its own facilities. Under the present system of regulation it is not possible for one railroad to increase the volume of its business by cutting rates below those of its competitors, or by offering other inducements of tangible value, and the only way to get and to hold a share of the business is to give service equal to or better than that offered by other roads serving the same territory.

Any railroad may improve its service and increase its revenues, or decrease its operating expenses, by making large investments in improved facilities and equipment, but such a policy is not always possible nor is it always profitable. As this is written the great Chicago, Milwaukee & St. Paul Railroad has just gone into the hands of receivers as a result of large expenditures for the extension of its lines and for the electrification of the western end of its property. The Milwaukee was the victim of circumstances rather than of bad policy, but the fact remains that the management of a railroad cannot make great expenditures of capital, upon which interest must be earned, without taking the serious risk that the very improvements designed to increase revenues and decrease operating expenses will be the cause of disaster.

It may be said that, at the present time, the policy of all of the railroads is constantly to improve the quality of the service offered to the shipping and traveling public. The official, in whatsoever capacity, and the man in the ranks, should bear in mind, always, that he is a salesman for his railroad, in that whatever he contributes to the better service helps to increase the business of his road.

One of the points which the general officer should impress upon his subordinate, and which the under officer should carry to the men in the ranks, is that the prosperity of the company, in large part at least, depends upon the quality of the service rendered, and that the quality of the service depends upon the combined efforts of all of the men making up the operating organization.

An engine failure or a hot box, a sticking triple valve or a dirty coach, a leaky box car or a low rail joint, will detract from the quality of the service and will contribute a more or less important share to the loss of business and to an excessive expense of operation. The railroad which has a reputation for smooth riding track and well handled trains gets the passenger business regardless of the quality and amount of advertising which it does and of the ability of its traffic solicitors.

92. *The Operating Policy.*

The plan of operation varies with the railroad and sometimes, to some extent, with the different divisions of the same railroad. In the handling of freight business, the policy of some railroads is to reduce the cost of operation to a minimum by increasing the tonnage per train to the highest possible point. It is by no means uncommon for the employees of a railroad to criticize the management for the heavy loading of trains, seeming to take the stand that the sole object is to get more work out of the force. Such criticism is not confined to train and engine men, who from a narrow viewpoint, may look upon the long train as a means of getting more out of them for the wages which they are paid, but is often heard around shops, round-houses and repair tracks, where the work of the individual is affected little if any by the fact that heavy tonnage trains are operated. Such criticism from employees is the direct result of lack of education in matters of policy by the foremen and officers directly in charge. Every foreman knows, or should know, that heavy tonnage per train mile is the most effective means of reducing operating expenses as a whole and is, therefore, good operating policy, and policy which should receive the unqualified support of every man in the organization.

Other railroads, and particularly those where the greater volume of traffic is light and high grade rather than heavy and low grade, follow the policy of moving the traffic in comparatively light trains at high speed, paying more attention to maintaining schedules than to securing heavy trainloads. Where this is the general policy, the entire organization should be lined

up to prevent delays and to keep the equipment in such condition that it will perform the fast service creditably.

It is unfortunately true that the general officers of a railroad do not always take sufficient pains to make the policy of operation clear to the organization and in such cases the minor executive must figure out for himself the plan of action, or work in the dark.

As a general proposition it may be said that the president of a railroad is mainly interested in the final results of operation as shown by the balance sheet and that the way in which results are accomplished is of minor importance to him. Operating executives sometimes feel that they are unjustly criticized when the expenses on their divisions seem to be out of line with earnings, when the causes of decreased income or increased outgo are due to conditions not entirely within their control.

In times of financial depression the shops are frequently called upon to make drastic reductions in force and in material expenditures, and at the same time they are called upon to furnish engines and cars to handle the traffic. Such times are trying for every man in the organization. The workman is laid off or asked to work short hours, the foreman is expected to get out the work with inadequate forces, the department heads are refused appropriations for equipment and facilities which they consider immediately necessary, but consider the position of the president and of the operating vice president. The stock and bondholders want, and are entitled to, a return upon their investment and if it is not forthcoming, it is the president who must explain why. It is in times of depression that it becomes doubly important for the organization to support the management in carrying out the necessary policies of retrenchment so that the railroad may weather the storm and come out financially sound, to the benefit of workers and owners alike.

CHAPTER XIV

RAILROAD ACCOUNTING

93. The Accounting System.

The actual keeping of railroad accounts is the business of a special department, more or less independent of all other departments, but the basic data of revenues and expense is furnished to the accounting department by officers and clerks in all branches of the service. The figures of revenues and expenses, when compiled by the accounting department, constitute the final record of performance.

The executive officer's interest in the accounting features of the railroad business is intimate and the better his understanding of the accounting system the greater will be his value to the company. The foreman or the higher mechanical officer should not get the idea that accounting is merely a clerical job which it is beneath his dignity to try to understand. Every activity of the railroad is expressed in dollars and cents in the revenue and expense accounts and the foreman's interest in these figures, particularly those which apply to his own departments, should be the same as in stubs of his personal checkbook.

The accounting system is uniform on all of the railroads and has been since 1907, when the Interstate Commerce Commission, complying with an Act of Congress, prescribed a classification of accounts to be used by all steam roads. The method of gathering accounting information varies somewhat on the different railroads, and the subdivision of the general accounts may not be identical, but the differences are unimportant and the man who understands accounting procedure on one line will have no difficulty in understanding the figures of them all.

94. *The Revenue Accounts.*

The operating revenue of the railroad comes from a number of sources and, under the Interstate Commerce Commission's ruling, must be segregated under the following heads:

Freight.	Switching.
Passenger.	Special service train.
Excess baggage.	Other freight train.
Sleeping car.	Water transfers—freight.
Parlor car.	Water transfers—passenger.
Mail.	Water transfers—vehicles and livestock.
Express.	Water transfers—other.
Other passenger train.	
Milk.	

Account No. 101. Freight, includes revenue from the transportation of freight and from transit, stop, and reconsignment privileges, upon the basis of lawful tariff rates.

Account No. 102. Passenger, includes the revenue from the transportation of passengers, based upon the tariff fares for passengers so transported; also from the transportation at special fares of excepted classes of passengers as provided by law.

Account No. 103. Excess baggage, includes the revenue from the transportation of baggage in excess of the free authorized allowances on the basis of the excess baggage rates.

Account No. 104. Sleeping car, includes the revenue from berth and seat accommodations furnished in sleeping cars on the basis of berth or seat rates for the space occupied.

Account No. 105. Parlor and chair car, includes the revenue from seat accommodations furnished in parlor, observation, chair, and other special passenger cars when operated in passenger train service or in special train service at seat rates for space occupied.

Account No. 106. Mail, includes the revenue from the transportation of mail at established rates for specified routes; from the use of railway post-office cars when in carrier's service trans-

porting mails; from the use of special mail facilities; and from bonuses for special mail transportation.

Account No. 107. Express, includes the revenue from the transportation of express matter and from use of facilities and trains and at stations incident to such transportation.

Account No. 108. Other passenger train, includes the revenue from transportation incident to the operation of passenger trains, not provided for otherwise.

Account No. 109. Milk, includes the revenue from the transportation of cream, sweet milk, skim milk, buttermilk, condensed milk, butterfat and smearcase or pot cheese, upon the basis of lawful tariffs at rates per package, regardless of weight.

Account No. 110. Switching, includes the revenue from switching service upon the basis of lawful tariff rates.

Account No. 111. Special train service, includes the revenue from running trains either on the basis of a rate per mile or a lump sum rate for the train.

Account No. 112. Other freight train, includes the revenue from transportation incident to the operation of freight trains not otherwise provided for, such as revenue in excess of tariff rates for the transportation of freight in revenue trains, with a guaranteed lump sum minimum.

Account No. 113. Water transfers—freight, includes the revenue from the transfer of freight by water transfers upon the basis of lawful tariff rates for local service.

Account No. 114. Water transfer—passenger, includes the revenue from the transfer of passengers by water transfer upon the basis of lawful tariff rates for local service.

Account No. 115. Water transfers—vehicles and livestock, includes the revenue from the transfer by water transfers upon the basis of lawful local rates, of vehicles of all classes; horses, cattle, and other animals; and government artillery and equipment.

Account No. 116. Water transfers—other, includes the revenue from water transfers not otherwise provided for.

Revenues are a thing with which a line executive officer has very little to do, but he is intimately interested in them for

the reason that without revenues there could be no expenses. As a man rises in the official ranks, the sources and amounts of revenues gain added importance to him and in order that he may understand where the revenue of the railroad comes from and how it is carried in the accounts he should have some knowledge of accounting procedure.

The language given in the description of the revenue accounts above is that of the Interstate Commerce Commission in the classification arranged for the guidance of the railroads in making their distribution and, while it is somewhat involved in legal forms, it will be readily understood by the railroad man without the necessity of further detail.

In addition to the revenue accounts pertaining strictly to rail line transportation as listed above, there are other sources of revenue classified under separate divisions. Some few of the railroads obtain revenue from the operation of water lines, and such revenues are included under a special general head called, "Transportation—Water Line," and subdivided in a manner similar to the rail line accounts. As only a few of the railroads operate water lines, it is not necessary here to enumerate these accounts.

Other revenues are included under a third classification, which are known as incidental revenues. Under this head are:

- Dining and buffet.
- Hotel and restaurant.
- Station, train and boat privileges.
- Parcel room.
- Storage—freight.
- Storage—baggage.
- Demurrage.
- Telegraph and telephone.
- Grain elevator.
- Stockyard.
- Power.
- Rents of buildings and other property.
- Miscellaneous.

A fourth general head covers the amounts received or paid for the use of joint facilities. Under these four general heads are included all of the revenues which the railroads earn. So far as the operating official is concerned, the principal interest lies in the two main sources of revenue, the transportation of freight and passengers. The other accounts contribute but a small proportion of the total revenue and such earnings are merely incidental to the main business of the railroads, which is to transport freight and passengers.

While it is not necessary for the mechanical executive to make an exhaustive study of revenue accounting it is important that he should understand the system of distributing the income of the railroad so that he may intelligently read and analyze the reports which come to him. If the student will examine the monthly and yearly reports of revenues and expenses, which most railroads distribute among the official family, he will see the application of the accounting principles which have been outlined in this chapter, and may figure for himself the relative importance of the various sources of revenue which his railroad earns.

95. Operating Expense Accounts.

With the operating expense accounts the mechanical department executive is directly concerned. To these accounts are charged all of the labor and material which he uses in the repair and handling of equipment and in the upkeep of shop facilities. Not only is the mechanical man directly interested in the accounts grouped under the heading of "Maintenance of Equipment," but also in certain accounts included under the heads of "Maintenance of Way and Structures" and "Transportation."

The general accounts included under the head of "Operating Expenses" are:

- I. Maintenance of Way and Structures.
- II. Maintenance of Equipment.
- III. Traffic.
- IV. Transportation—Rail Line.

V. Transportation—Water Line.

VI. Miscellaneous Operations.

VII. General.

VIII. Transportation for Investment.

Each of these general accounts is divided into a number of primary accounts, and it is important that the executive should know just what these accounts are and what items of expense are properly chargeable to them. The primary accounts into which the general accounts are divided are as follows:

I. Maintenance of Way and Structures.

201. Superintendence.

202. Roadway maintenance.

203. Roadway depreciation.

204. Underground power tubes.

205. Underground power tubes—depreciation.

206. Tunnels and subways.

207. Tunnels and subways—depreciation.

208. Bridges, trestles, and culverts.

209. Bridges, trestles, and culverts—depreciation.

210. Elevated structures.

211. Elevated structures—depreciation.

212. Ties.

213. Ties—depreciation.

214. Rails.

215. Rails—depreciation.

216. Other track material.

217. Other track material—depreciation.

218. Ballast.

219. Ballast—depreciation.

220. Track laying and surfacing.

221. Right of way fence.

222. Right of way fence—depreciation.

223. Snow and sand fences and snowsheds.

224. Snow and sand fences and snowsheds—depreciation.

225. Crossings and signs.

226. Crossings and signs—depreciation.

- 227. Station and office buildings.
- 228. Station and office buildings—depreciation.
- 229. Roadway buildings.
- 230. Roadway buildings—depreciation.
- 231. Water stations.
- 232. Water stations—depreciation.
- 233. Fuel stations.
- 234. Fuel stations—depreciation.
- 235. Shops and enginehouses.
- 236. Shops and enginehouses—depreciation.
- 237. Grain elevators.
- 238. Grain elevators—depreciation.
- 239. Storage warehouses.
- 240. Storage warehouses—depreciation.
- 241. Wharves and docks.
- 242. Wharves and docks—depreciation.
- 243. Coal and ore wharves.
- 244. Coal and ore wharves—depreciation.
- 245. Gas producing plants.
- 246. Gas producing plants—depreciation.
- 247. Telegraph and telephone lines.
- 248. Telegraph and telephone lines—depreciation.
- 249. Signals and interlockers.
- 250. Signals and interlockers—depreciation.
- 251. Power plant dams, canals and pipe lines.
- 252. Power plant dams, canals and pipe lines—depreciation.
- 253. Power plant buildings.
- 254. Power plant buildings—depreciation.
- 255. Power substation buildings.
- 256. Power substation buildings—depreciation.
- 257. Power transmission systems.
- 258. Power transmission systems—depreciation.
- 259. Power distributing systems.
- 260. Power distributing systems—depreciation.
- 261. Power line poles and fixtures.
- 262. Power line poles and fixtures—depreciation.

- 263. Underground conduits.
- 264. Underground conduits—depreciation.
- 265. Miscellaneous structures.
- 266. Miscellaneous structures—depreciation.
- 267. Paving.
- 268. Paving—depreciation.
- 269. Roadway machines.
- 270. Roadway machines—depreciation.
- 271. Small tools and supplies.
- 272. Removing snow, ice, and sand.
- 273. Assessments for public improvements.
- 274. Injuries to persons.
- 275. Insurance.
- 276. Stationery and printing.
- 277. Other expenses.
- 278. Maintaining joint tracks, yards, and other facilities—Dr.
- 279. Maintaining joint tracks, yards, and other facilities—Cr.

II. Maintenance of Equipment.

- 301. Superintendence.
- 302. Shop machinery.
- 303. Shop machinery—depreciation.
- 304. Power plant machinery.
- 305. Power plant machinery—depreciation.
- 306. Power substation apparatus.
- 307. Power substation apparatus—depreciation.
- 308. Steam locomotives—repairs.
- 309. Steam locomotives—depreciation.
- 310. Steam locomotives—retirements.
- 311. Other locomotives—repairs.
- 312. Other locomotives—depreciation.
- 313. Other locomotives—retirements.
- 314. Freight train cars—repairs.
- 315. Freight train cars—depreciation.
- 316. Freight train cars—retirements.
- 317. Passenger train cars—repairs.

- 318. Passenger train cars—depreciation.
- 319. Passenger train cars—retirements.
- 320. Motor equipment of cars—repairs.
- 321. Motor equipment of cars—depreciation.
- 322. Motor equipment of cars—retirements.
- 323. Floating equipment—repairs.
- 324. Floating equipment—depreciation.
- 325. Floating equipment—retirements.
- 326. Work equipment—repairs.
- 327. Work equipment—depreciation.
- 328. Work equipment—retirements.
- 329. Miscellaneous equipment—repairs.
- 330. Miscellaneous equipment—depreciation.
- 331. Miscellaneous equipment—retirements.
- 332. Injuries to persons.
- 333. Insurance.
- 334. Stationery and printing.
- 335. Other expenses.
- 336. Maintaining joint equipment at terminals—Dr.
- 337. Maintaining joint equipment at terminals—Cr.

III. Traffic.

- 351. Superintendence.
- 352. Outside agencies.
- 353. Advertising.
- 354. Traffic associations.
- 355. Fast freight lines.
- 356. Industrial and immigration bureaus.
- 357. Insurance.
- 358. Stationery and printing.
- 359. Other expenses.

IV. Transportation—Rail Line.

- 371. Superintendence.
- 372. Dispatching trains.
- 373. Station employees.
- 374. Weighing, inspection and demurrage bureaus.
- 375. Coal and ore wharves.
- 376. Station supplies and expenses.

- 377. Yardmasters and yard clerks.
- 378. Yard conductors and brakemen.
- 379. Yard switch and signal tenders.
- 380. Yard enginemen.
- 381. Yard motormen.
- 382. Fuel for yard locomotives.
- 383. Yard switching power produced.
- 384. Yard switching power purchased.
- 385. Water for yard locomotives.
- 386. Lubricants for yard locomotives.
- 387. Other supplies for yard locomotives.
- 388. Enginehouse expenses—yard.
- 389. Yard supplies and expenses.
- 390. Operating joint yards and terminals—Dr.
- 391. Operating joint yards and terminals—Cr.
- 392. Train enginemen.
- 393. Train motormen.
- 394. Fuel for train locomotives.
- 395. Train power produced.
- 396. Train power purchased.
- 397. Water for train locomotives.
- 398. Lubricants for train locomotives.
- 399. Other supplies for train locomotives.
- 400. Enginehouse expenses—train.
- 401. Trainmen.
- 402. Train supplies and expenses.
- 403. Operating sleeping cars.
- 404. Signal and interlocker operation.
- 405. Crossing protection.
- 406. Drawbridge operation.
- 407. Telegraph and telephone operation.
- 408. Operating floating equipment.
- 409. Express service.
- 410. Stationery and printing.
- 411. Other expenses.
- 412. Operating joint tracks and facilities—Dr.
- 413. Operating joint tracks and facilities—Cr.

- 414. Insurance.
- 415. Clearing wrecks.
- 416. Damage to property.
- 417. Damage to live stock on right of way.
- 418. Loss and damage—freight.
- 419. Loss and damage—baggage.
- 420. Injuries to persons.

V. Transportation—Water Line.

- 431. Operation of vessels.
- 432. Operation of terminals.
- 433. Incidental.

VI. Miscellaneous Operations.

- 441. Dining and buffet service.
- 442. Hotels and restaurants.
- 443. Grain elevators.
- 444. Stockyards.
- 445. Producing power sold.
- 446. Other miscellaneous operations.

VII. General.

- 451. Salaries and expenses of general officers.
- 452. Salaries and expenses of clerks and attendants.
- 453. General office supplies and expenses.
- 454. Law expenses.
- 455. Insurance.
- 456. Relief department expenses.
- 457. Pensions.
- 458. Stationery and printing.
- 459. Valuation expenses.
- 460. Other expenses.
- 461. General joint facilities—Dr.
- 462. General joint facilities—Cr.

VIII. Transportation for Investment—Cr.

96. *The Foreman's Part in Accounting.*

All of the money spent in all of the railroad departments must be charged to some one of the foregoing accounts. While the mechanical executive is principally interested in those

accounts which come under the head of "maintenance of equipment" there is much work done in shops and roundhouses, or by mechanical forces, which must be charged to accounts which come under the other general heads. The shop foreman has a great deal to do with the proper distribution of expenses, as he is usually required to show the proper charge on all material requisitions and frequently on the time slips of the men under his supervision.

If the foreman does not show the proper charge on time slips and requisitions the expense will be charged by the clerks and accountants to the wrong accounts and he may be criticized for excessive expenditures when the whole difficulty lay in incorrect charges. The foreman is held accountable for expenses in his department, and the mechanical officials, as a whole, are judged by their performance as indicated by the accounts, so that it is evident that the executive cannot afford to be ignorant of the principles of disbursement accounting.

97. Charges to Maintenance of Way Accounts.

Work is very frequently done by mechanical department forces which is properly chargeable to one of the maintenance of way accounts. If material and labor so used is not properly charged on time slips and material requisitions the charges will go into the maintenance of equipment accounts and will show up against the record of the mechanical department officers.

For example, all work done on buildings and grounds is chargeable to maintenance of way. If mechanical forces make repairs to roundhouses or shops, as they frequently do at small points, the charge should be made against the proper maintenance of way account. On many railroads repairs to frogs, switch stands, track tools, and other track material are made in the shops by mechanical department forces, but the expense is properly chargeable against the several roadway accounts. Where the accounting system of the railroad is well designed and properly supervised, work done by one department for another is handled on department orders so that the charges

for labor and material may be correctly taken care of, but even in this case it is necessary for the foreman to know something about the classification of accounts or else he will not know when the work his men are engaged on is a charge to some other department.

98. Charges to Transportation Accounts.

A great deal of the work done in roundhouses, and some of the materials drawn from the stores by roundhouse men, is chargeable to transportation accounts. All of the oil and grease used for the lubrication of locomotives should be charged against transportation accounts, 386, lubricants for yard locomotives, and 398, lubricants for train locomotives. The supplies, such as oil cans, scoops and hand tools, which are placed on locomotives should be charged to accounts 387, other supplies for yard locomotives, and 399, other supplies for train locomotives.

All of the labor of handling engines at roundhouses is chargeable to accounts 388, enginehouse expense—yard, and 400, enginehouse expense—train. In order to show clearly just what expenses should be charged to these accounts the following instructions are quoted from the Interstate Commerce Commission's classification.

“400. Enginehouse Expenses—Train.—This account shall include the expense of caring for and preparing locomotives for transportation train service, including a proportion of such expenses as are common to train, yard switching, and work service.

“Enginehouse Men.—The pay of enginehouse employees engaged in wiping, cleaning, watching, and dispatching locomotives; preparing and keeping fires, dumping ashes, washing boilers, cleaning fire boxes, air-brake equipment, and front ends of locomotives; checking locomotive tool equipment, cleaning ash and cinder pits, operating turntables, drying sand, inspecting smoke stacks and ash pans; and moving locomotives around engine yards when operated by hostlers; also a proportion of the pay of enginehouse foremen and their clerks.

“Miscellaneous Expenses.—The cost of tools and supplies and sundry expenses on account of caring for and preparing locomotives at enginehouses.”

The importance of correct accounting for all labor employed and material used cannot be over-emphasized, and the higher a man goes in the service the more he will appreciate this fact. All of the detail figures covering the distribution of the time of workmen and the cost of the items of material are accumulated by the accounting department and each official is charged with the expense which he incurs in the performance of the work of his department or division. The general officers of the railroad judge the performance of the minor officers by what these figures show.

CHAPTER XV

TERMS USED IN ACCOUNTING, ETC.

Some of the terms used in railroad accounting and operating statistics, with their definitions, are as follows:

All other expenses.—This includes incidental general expenses which are not properly chargeable to other accounts.

All other revenue.—Revenue from transportation in incidental services not otherwise defined.

Average haul (freight).—The average distance the freight moves.

Average journey (passenger).—The average distance traveled per passenger.

Average miles represented by income account.—The classification of the steam railroads being based upon operating revenue is variable. To supply a guide for comparative purposes the mileage represented by the railroads reporting is given.

Bad-order cars.—Cars in an unserviceable condition retired from service until repairs are made.

Book value.—It is the value at which the property is carried in the property investment account in the general ledger of the carrier.

Capacity-freight cars.—The number of tons a freight car is designed to handle. Aggregate capacity is the sum of the capacity of all cars.

Car-mile.—The movement of a unit of car equipment 1 mile.

Car shortage.—The number of cars required for immediate loading in excess of the supply available.

Car surplus.—The number of serviceable cars in excess of current requirements.

Class I railroads.—Railroad companies engaged in interstate commerce having annual operating revenue above \$1,000,000.

Class II railroads.—Railroad companies engaged in interstate commerce having annual operating revenues from \$100,000 to \$1,000,000.

Class III railroads.—Railroad companies engaged in interstate commerce not included in classes I and II.

Dividends declared out of income.—This is the amount paid in dividends on stock from the net income.

Dividends out of surplus.—This is the amount of dividends on stock paid out of surplus funds.

Express revenue.—Revenue from the transportation of express matter and from use of facilities on trains or at stations incidental thereto.

Freight density.—The revenue ton-miles per mile of road.

Freight revenue.—Revenue from the transportation of freight and from transit, stop and reconsigning privileges upon the basis of lawful tariff rates.

Freight traffic.—The volume of goods transported.

General expense.—Expenses incurred of a general character not otherwise included, such as those for general administration and accounting, and those of the financial, law, real estate, tax, and claim departments.

Gross ton-miles.—Gross tons transported 1 mile. Gross tons include the weight of the cars, including the caboose, as well as the weight of the load and the weight of the empty car when hauled empty. It may or may not include the weight of the locomotive and tender as indicated.

Hire of equipment.—This includes the net credit balance of (1) amounts receivable accrued for the use of the accounting company's locomotives and cars leased or interchanged, and (2) accounts payable accrued for the use of locomotives and cars of other carriers leased or interchanged and for the use of freight cars of individuals and companies not carriers.

"Home car."—A car at home on its owner's rails.

"Home line."—This term is used in connection with cars and has reference to the line owning the car.

Interest on funded debt.—The current accruals of interest on all classes of debt; also interest accruals on debenture stock and on receivers' certificates issued for a time of more than one year.

Interest on unfunded debt.—Interest accruals on unfunded debt such as short-term notes payable on demand or having dates of maturity one year or less from dates of issue, interest on receivers' certificates issued for a term of one year or less, interest on matured funded securities and open accounts, including interest on overcharge claims, etc.

Investment in equipment.—This includes the cost of the several classes of equipment, such as cars and locomotives, owned by the carrier or held under equipment trust agreements for purchase.

Investment in miscellaneous properties.—This includes all property not devoted to transportation service.

Investment in road.—This includes the cost of land, fixed improvements, and roadway machines and tools devoted to transportation service.

Joint facility rent.—This includes amounts receivable or payable accrued for rent of tracks, yards, terminals, and other facilities owned or controlled by the accounting company and used jointly with other companies or individuals.

Locomotive-miles (helpers).—The number of miles run by a locomotive engaged in helping a train over a division or that portion covered by the run or on important grades.

Locomotive-miles (light.)—The number of miles run by a locomotive without cars.

Locomotive-miles (principal).—The number of miles run by a locomotive handling a train.

Locomotive-miles (train switching).—The miles allowed train locomotives while engaged in switching service at terminals and way stations.

Locomotive-miles (work service).—The miles run by a locomotive in worktrain service, also the miles of locomotives engaged solely in shop or material yard switching service.

Locomotive-miles (yard switching).—The miles allowed yard locomotives while switching in yards where regular switching service is maintained.

Mail revenue.—Revenue from the transportation of United States mail.

Maintenance of equipment.—Cost of maintaining equipment used in railway operations, such as locomotives, cars, shop machinery, etc.

Maintenance of way and structures.—Cost of maintaining fixed improvements which are devoted to railway operations, such as roadway and tracks, bridges, buildings, etc.

Miles of road or miles of line.—The length of the railroad, the measurement of the single-track mileage.

Miles of track.—The length of all tracks—first, second, third, or other main tracks and yard tracks and sidings, spur tracks, etc.

Net income available for dividends.—This represents the sum available after all expenses have been paid, including interest on indebtedness, etc.

Net operating revenue.—The total operating revenue less the total operating expenses.

Net railway operating income.—This is the railway operating income plus or minus hire of equipment and joint facility rent credits or debits.

Net ton-miles.—Net tons transported 1 mile. Net tons is the weight of the freight constituting the contents of the freight cars and includes both revenue and nonrevenue tons.

Nonrevenue tons carried.—The weight of the nonrevenue or company freight carried.

Nonrevenue ton-miles.—Nonrevenue tons transported 1 mile. Nonrevenue tons is the weight of fuel, materials, and other supplies transported for the account of the carrier from which no revenue is derived.

Other deductions.—This includes miscellaneous deductions not mentioned specifically.

Other income.—This includes all income from other sources, including miscellaneous operating income.

Operating ratio.—The percentage which the total operating expenses bears to the total operating revenue.

Passenger density.—The revenue passenger miles per mile of road.

Passenger revenue.—Revenue from the transportation of passengers based upon tariff fares for passengers so transported.

Passenger traffic.—The number of passengers transported.

Property investment.—Property investment represents the amount of money expended for the property of the carriers devoted to transportation service as reported by them to the Interstate Commerce Commission.

Railway operating income.—This is the net operating revenue less taxes and uncollectible railway revenue.

Railway tax accruals.—This includes taxes of all kinds (including Federal income tax) relating to railway property, operations, and privileges on whatever basis assessed.

Rent for leased roads.—Amount receivable or payable for exclusive use of road, tracks, or bridges (including equipment or other railway property covered by the contract).

Revenue passengers carried.—The number of revenue passengers carried, including local and interline.

Revenue passenger-miles.—The number of revenue passengers carried 1 mile.

Revenue ton-miles.—Revenue tons transported 1 mile. Revenue tons is the weight of the freight transported upon which freight charges are paid.

Revenue tons originated on line.—The weight of the freight loaded into freight cars for transportation and upon which freight charges are assessed. This includes only the freight actually loaded on the carriers' lines for both local and interline movement.

Revenue tons transported.—This includes the tonnage transported locally and the tonnage received from connecting lines.

Second, third, and other main tracks.—Main tracks laid parallel to the first main track.

Single-track mileage or first main-track mileage.—The length of the first main track.

Switching and terminal companies.—Switching and terminal companies are usually owned by the railroads and are included in the appropriate class.

Tare ton-miles.—Gross ton-miles minus net ton-miles.

Trackage rights.—Right to operate trains over specified tracks granted by the owning line by contract or other arrangement.

Track capacity.—The number of cars a length of track will hold.

Tractive power (locomotives).—The weight the locomotive can pull, commonly termed the drawbar pull.

Traffic expense.—Expenses incurred for advertising, soliciting, and securing traffic for the carrier's lines and for preparing and distributing tariffs governing such traffic.

Train-mile.—The movement of a train a distance of 1 mile.

Transportation expense.—Expenses incurred for transporting persons and the property of others, including the expenses of station, train, yard, and terminal service; also the expenses of transporting company material in transportation service trains.

Total income.—The sum of net railway operating income and other income.

Total operating expenses.—Expenses of furnishing transportation service, including the expenses of maintaining the plant used in the service.

Total operating revenue.—The revenue received from transportation and service incidental thereto.

Uncollectible railway revenue.—Includes the amount of uncollected revenue charges against companies and individuals representing tariff charges for service rendered (including not only the accounting carrier's revenue charges, but also charges advanced to other carriers) when such amounts have been properly determined to be uncollectible.

Yard tracks and sidings.—All tracks not used as main tracks, including yard tracks, spur tracks, industry tracks, steam tracks, etc.

CHAPTER XVI

EQUIPMENT MAINTENANCE ACCOUNTS

99. General Comment.

As the mechanical executive is mainly concerned with the maintenance of equipment accounts, and as a thorough knowledge of them is essential to the intelligent handling of his work some space will be devoted to their description. The statistical side of railroading is becoming yearly more important and the official of the future will need to know more about accounts and figures of performance than did his predecessor.

The revenues and expenses of the railroads are closely watched by the Interstate Commerce Commission and the Transportation Act, 1920, provides that rates shall be set so as to yield a certain profit on operation, provided that operating expenses are reasonable. The prosperity of the railroads depends upon their keeping their expenditures reasonable, and being able to show that they are reasonable by the figures which they submit to the government. It will be readily understood, therefore, why it is necessary for the railroad executive in all branches of the service to understand the system of accounting, and further why it is essential that he watch the accounts and statistics which pertain to his department so as to make his performance creditable.

100. Superintendence.

To account No. 301 is charged the pay of all officers in charge of or engaged in the maintenance of equipment. Such officials as vice presidents in charge of mechanical department, superintendents of motive power, mechanical superintendents, mechanical engineers, chief chemists, general equipment inspectors, engineers of tests, electrical engineers, master car builders, master

mechanics, general foremen, car and boiler inspectors, and assistants to any of these officers, are charged to this account. The pay of clerks and attendants to these officials and their office and other expenses are a further charge to superintendence.

101. Shop Machinery.

Account 302 includes the cost of repairing machinery and other apparatus, including special foundations, in shops and enginehouses. This account covers only the larger machines, such as lathes, planers, milling machines, steam hammers and similar equipment, and also power plant machinery when not located in a separate power plant. Small hand tools which are soon worn out are charged to "shop expense."

102. Depreciation Accounts.

Under various heads, such as shop machinery, locomotives, freight cars, etc., will be found depreciation accounts. The charges to these accounts do not represent the actual current expenditure of any money but merely an arbitrary charge, based upon the value of the equipment, which represents the decrease in value due to age or obsolescence. Depreciation is taken care of entirely by the accounting department. While these charges enter into the maintenance of equipment accounts they are not under the control of the mechanical officers.

103. Power Plant Machinery.

Account No. 304 includes the cost of repairing machinery and other apparatus, including special foundations, for generating power in power plants used for the operation of trains and cars and to furnish power, heat and light for general purposes.

104. Steam Locomotive Repairs.

Account 308 is the most important account with which the shop man has to do. The greater part of the labor and material used in locomotive shops and roundhouses is charged to this account and the efficiency of the locomotive division of the mechanical department depends largely upon the relation of this expense to the amount of work turned out.

This account includes the cost of repairing transportation service steam locomotives and tenders, including all appurtenances, and the cost of small hand tools used in repair work.

105. Freight Train Car Repairs.

Next to the repair of locomotives, the upkeep of freight cars is the most important activity of the mechanical department. This account includes the cost of all labor and material used in the repair of freight cars, and also the cost of small tools used in making such repairs.

106. Other Repair Accounts.

Other repair accounts are provided to which are charged the labor and material used in repairing passenger cars, work equipment, floating equipment, etc., but as these accounts will be readily understood from their names, it is not necessary to describe them in detail. A copy of the complete classification of accounts is to be found in almost any mechanical office where accounts are kept, and the foreman who is in doubt about any point can easily consult this authority.

107. Shop Expense.

In addition to the regular numbered accounts every shop accountant carries a clearing account called "shop expense," to which is charged such items of expense as cannot be directly distributed. The pay of foremen and clerks, sweepers, watchmen, general laborers, power plant engineers, and firemen employed in shops, roundhouses, or car departments is charged to this account as is the cost of power, light and heat for shop buildings. All small tools and supplies are also charged to "shop expense."

The total amount charged to this account is prorated at the end of each month over the primary accounts affected on the basis of the percentage which the charge to shop expense bears to the total of the primary accounts. If the total direct charges to the various repair accounts should amount to \$100,000.00, while the charges to "shop expense" were \$30,000.00 the shop

expense ratio, sometimes called overhead, would be 30% and this percentage would be added to each of the repair accounts.

It is fully as important for the foreman to watch his shop expense as it is to keep close track of the direct charges to locomotive and car repairs. Economies which he effects in the actual completion of repairs may be offset by heavy indirect charges for general labor, tools or other items.

The overhead expense in factories is frequently a much larger item than is the direct cost of production and overhead percentages of 100% to 200% are not at all uncommon. The principal reason for the higher overhead in factories is that a proper charge is made against each item of production to take care of the interest on the money invested in plant and equipment and of the depreciation on buildings and machinery. The railroads have never adopted this system of accounting and their costs are not, therefore, comparable with factory or contract shop costs.

108. Store Expense.

Another clearing account used in the shop accounting system is that of "store expense." To this account is charged the expense connected with purchasing, handling, storing and distributing materials. The total charge to this account is prorated over the regular accounts to which material has been charged on the same basis as shop expense is divided between the labor accounts.

109. Procedure of Shop Accounting.

The basis upon which the distribution of the total labor and material expense of the mechanical department is made are the time slips of the workmen and the material requisitions issued by the foremen. The practice on various railroads in making the distribution of the payroll to the several accounts varies widely. The system universally in use years ago was to have a distribution clerk make the rounds of the shop every day or so getting from each workman the numbers of the engines upon which he had worked. This was a very crude system indeed,

and when the railroads began to investigate costs they found that their detail figures were so unreliable as to be entirely useless. In recent years, therefore, the system of gathering the information as to the time spent on various jobs by the individual workmen has been radically changed and improved on a majority of the railroads.

On some lines the present system of accounting is modeled after that employed in factories, and either timekeepers or time clocks are used to record the actual hours and minutes spent by each workman on each job. On other roads the workman is required to keep his own time on a special distribution card, while on a few of the less progressive lines the old system of distribution is still in effect. With every year the importance of knowing the cost of the various operations and the total cost of repairs on the several classes of equipment becomes greater, and in the not far distant future the railroad foreman will be expected to know as much about the cost of the operations performed in his department as does the factory foreman. The subject of shop costs will be taken up in a later chapter and it is the intention here merely to point out the importance, to the mechanical executive, of having a good working idea of how railroad accounts are handled and how they can be made to help him in his work.

110. The Old Order and the New.

In years gone by, the shop, roundhouse, or car foreman knew and was expected to know very little about accounting or about the figures which represented the performance of his department. He ran his department with what labor and what material he could get and all he knew about expense was the total of his pay roll. That time has passed, and the department foreman is now expected to take an active interest in the charges of labor and material expense to the various accounts and to the various units of power and rolling stock.

Railroad managements in the present day analyze the costs of repairs to the various engines which pass through the shop and ask for explanations when they seem excessive. Comparisons

are made between the cost of making similar repairs at the different shops and the efficiency of the supervising force is measured largely by the unit cost of repairs. It is to the interest of the modern foreman, therefore, that he devote sufficient attention to the accounting features to know that expense charges are properly made, and that he himself analyze the accumulated figures so as to detect and correct inefficiencies in his department.

The policy of present progressive railroad managements is to place all of the figures of expenses and performance in the hands of the interested executives so as to inspire their co-operation in the efficient operation of the road. Not only is the master mechanic expected to take an interest in the cost of freight locomotive repairs per gross ton mile, but so is the roundhouse foreman and the several shop foremen.

CHAPTER XVII

PROBLEMS OF THE MECHANICAL DEPARTMENT

111. Outline.

A railroad is equipped with a certain number of locomotives, of various classes, and with a certain number of cars of different capacities and designs. This equipment may be well or poorly designed and constructed, it may be well fitted to the requirements of the railroad, or it may not, but whatever its character and condition it is the business of the mechanical department to keep it in the best possible condition for the handling of freight and passengers and for the hauling of trains.

The condition of power and rolling stock on the railroads is a matter which is closely followed not only by railroad men but by financiers and by men in other businesses. A compilation is made monthly of the number of engines in service, the number requiring general repairs, the number laid up in good condition and the number requiring running repairs and these figures are closely followed by big business men everywhere, because they have an influence on general business conditions. If general business conditions are good and traffic is normal while the condition of the motive power of the railroads is below normal, it is a certain indication that the railroads must soon be in the field for additional help and in the market for more materials.

The condition of cars and the surplus or shortage of such equipment available for loading is another matter which is closely watched. Transportation is such an important factor of our industrial life that what the railroads are doing or intend to do is of vital importance to the nation as a whole. The railroads are the largest employers of labor and the greatest purchasers of material of any of the industries and their ability to

employ men and to buy supplies has a very important effect on the general business condition of the nation.

The problems of the railroad mechanical department are similar to, but more complicated than, those of the factory. The factory produces a certain limited number of products of more or less standard design, while the output of the railroad shop consists of repaired locomotives, the work on no two of which is exactly identical. In the finishing of certain standard parts the railroad shop may proceed along manufacturing lines but the volume of such work is very small as compared with the total.

The time factor is more important in the railroad shop than in the factory, while the cost factor is no less important.

A locomotive or car out of service is just so much capital which earns no return and the more time engines spend in the shop the greater must be the total investment in power to keep the trains moving. Under normal conditions 16% to 17% of all of the locomotives owned by all of the railroads in the United States are either in shop or are awaiting repairs. If inefficiency in the mechanical departments raises this ratio to 20% the transportation business of the country is slowed up and financial loss is suffered all along the line.

Hardly a year passes without a serious car shortage in some part of the country in spite of all the measures which have been adopted to concentrate equipment at points where there is an unfilled demand. If the railroads purchased enough equipment to cover every possible demand, their investment in cars would be greatly increased, more money would be required for interest on indebtedness and a reduction in the already insufficient margin of profit would result.

The importance of keeping the power and rolling stock in condition for service will be readily appreciated and this is the duty of the mechanical department. The problem would be comparatively simple if unlimited repair facilities were available, and if the cost of repairs was a matter which could be ignored. Such, however, is not the case. Expenses must be held within certain limits, and further investment in improved

facilities can only be justified by the promise of decreased repair costs.

112. The Working Force.

The mechanical official works with men, materials and machinery to accomplish the desired results. Materials may be purchased on specifications which fit them for the purpose for which they are to be used. Machines may be installed and tooled up to perform certain operations. But the hand and brain of the workman is required to operate the machines and to fashion the materials to their proper form. The purchase of suitable materials and the installation of proper machinery is largely an engineering problem, but the molding of an efficient working force is the task of foremen, shop superintendents and master mechanics.

The most important duty of the mechanical officer is to organize an efficient working force and the task is by no means a simple one whether the shop be large or small. Men are not cast in a common mold and each individual requires special handling to bring out the best that is in him. One of the problems of the foreman is to study his men, to determine the best way in which each may be handled, to decide the position for which each individual is best fitted, and to build up his organization by fitting men in according to their several abilities.

In some of the European countries the proper selection of men for special work is given far more attention than it has ever been in this country. In some of these shops the apprentice boys are placed in a department by themselves where they are carefully instructed and studied by competent officials. Each boy is given the particular class of work for which he is best fitted, temperamentally. The boy with a fine sense of feeling is placed on a machine where close work is required, while the big husky who takes pride in his strength is given the heavy erecting work.

Selection of men in the railroad shops in this country has not been the subject of any great amount of scientific study and the placing of individuals is left largely in the hands of the

department foremen and gang foremen. A machinist is either a floor hand or a machine hand and that is about as far as our division of ability goes. The foreman who makes a study of his men will find, however, that a mechanic who will do good work and plenty of it from a brass lathe is no good on the big planer, that the man who can set valves well and quickly will botch a job of fitting driving boxes.

Certain men like to do certain things, and when they are allowed to do what they like to do, the chances are ten to one that they will do it well and quickly. Most of the human inefficiency in the world is due to the misplacing of men. The man who fails utterly as a doctor might have been a great success as a barber, the one who cannot make a living on a farm might have succeeded as a stock salesman.

There is no particular mystery about human nature and no man needs to study psychoanalysis in order to understand the reactions of those with whom they come in contact. Men readily show their likes and dislikes and it is a mistake to keep any workman at a task for which he has distaste or in a gang with other men with whom he cannot get along.

Various plans of inducing men to increase their output will be fully discussed in a following chapter but it may be said here that no system of pay for individual effort will overcome the bad effect of misplaced men. The man who works merely for the wages he receives is never a good nor an efficient workman, there must be an incentive other than money to bring out the best ability and the best effort which is in the man. One of the worst faults of our industrial system of quantity production is that it tends to reduce the man to the status of a machine and makes of him a mere unit in a complicated mechanism rather than an individual preserving his identity as a part of an organization.

Any one who has been in close touch with industrial affairs cannot help but have observed that men are being constantly called from the railroads to take official positions in factories and in business organizations. The reason for this condition is clear. The railroad man has not been subjected to the operation

of production systems but has been permitted to develop normally along the lines of his abilities and ambitions, while the factory man has been held in the production rut. When men are required for executive positions, where all-around knowledge and training is required, the factory mechanic, who can perform a small range of operations with maximum efficiency, is not fitted for the job and the coveted position goes to the railroad man who has a good general knowledge of features of the mechanical arts.

113. Facilities.

There are a few modern and well equipped railroad shops but there are thousands which are neither modern nor well equipped. It is from these old shops, designed and constructed from the models of a past century and equipped with obsolete machinery and facilities, that the greater part of the output of repaired locomotives and cars comes. The railroads in the past quarter of a century have had little money to spend upon the erection of new shop and roundhouse facilities or in the purchase of the latest creations of the machine builder's art, and the mechanical man of today overhauls Santa Fe and Mallet type locomotives on the same pits and with the same facilities which his father used in making repairs to eight and ten wheel engines. The sides of shop buildings have been knocked out to permit the extension of tracks to hold the longer locomotives, air tools and autogenous welding and cutting have come to ease the burden, larger capacity cranes and hoists have been installed to lift the increased loads, but on the whole the improvement of shop buildings and facilities has nowhere near kept pace with the increased size of power and rolling stock units.

The task of the railroad mechanical man is to do the best he can with the facilities and equipment and to hope for the day when transportation revenues will be sufficiently above expenses to permit the management to make some investment in up-to-date buildings and machinery. There is, however, surprisingly little difference between the output and the cost of output of the antiquated and the strictly modern shop and the fact

speaks volumes for the ability of the men who handle the mechanical affairs of the railroads. The old shops are turning out good work and lots of it because mechanical men have learned to make the very best use of the facilities provided.

One of the principal duties of the mechanical officer is to improvise facilities and to strengthen equipment to take care of the ever increasing volume of work which must be handled through the shops. A request for a new machine or a new building must be supported by indisputable evidence that the expenditure will be more than justified by decreased costs, and even when the fact is proven the president's authority for the investment is not always forthcoming. Any body can get pleasant sounds from a phonograph, but it takes an artist to tease music out of a saxophone.

114. The Working Plan.

To the practical man the terms "efficiency," "system," and "planning" have a formidable sound. Systematizers and efficiency engineers, who have come into being within the last few years, have invested these words with a mystery which does not belong to them and which has no proper place in shop management. Efficiency is merely a word which means getting the maximum output with the minimum input, system means the arrangement of things in proper order and planning simply means the outlining of a scheme to be followed in the performance of a given task.

It is unfortunate that impractical theorists have given these words a bad name by clouding their meaning in a jargon of senseless technical phrases, for there are no other words in the language to replace them. It should be understood, however, that when such words are used in these chapters there is no intention to inflict upon the student a mass of untried or impractical theory, but rather are the words used strictly in the sense in which Webster defines them and as they are applied in everyday shop practice.

Planning in the mechanical department, then, is nothing more nor less than lining up the work to be done tomorrow,

and next week, and next month. It is hardly necessary to argue the necessity for planning. The foreman who has a dozen or a hundred men under him realizes that he must think ahead so as to keep his force busy and to have the work come along in the sequence in which it is required. The plan of work in a round-house or on a rip track must be largely a day-to-day proposition and even the day's plan must be subject to change at a moment's notice. In the backshop or in the shop where cars are given heavy repairs the plan of operation may be made to cover a month and, in a general way, a year.

It is not the intention here to go into the details of planning, as that will be left for later chapters, but merely to point out as one of the problems of the mechanical department the desirability of working to a definite plan. Planning involves the lining up of materials and men required to complete the repairs to the equipment. The output of the shop largely depends upon how well the work is planned. If material requirements are not foreseen well in advance there will be long delays to power and rolling stock passing through the shop. If the work of the various departments is not arranged so that each part of the locomotive or car is ready when the erecting floor calls there are further delays and unavoidable inefficiency. It is not always the man who works hard who works efficiently; in fact, many very hard workers do so much unnecessary work that their actual output is less than that of men who work their hands less and their heads more.

The foreman is essentially a brain worker and all of the manual skill in the world will not substitute for constantly active thoughts. If the foreman cannot employ himself constantly in planning the work of his department, in devising improved methods of performing the work, in giving advice and instruction to the workmen under him, then there is something wrong with him and he needs to study up or he will not be in line for further promotion.

One of the successful efficiency engineers used to say that a man should spend one-third of his time planning his work, one-third working, and the other third telling his superiors what

he was doing. A better division of time would be one-half planning and one-half seeing that the plan was carried out. When a man is accomplishing results it is not necessary for him to spend much of his time advertising, and when he does too much of that sort of thing he is very likely to make himself unpopular with his superiors.

115. Departmental Relations.

One of the problems of the mechanical official is to maintain the proper relations with the transportation department without subordinating the importance of his work to theirs. The mechanical department is responsible for the condition of the power and rolling stock but it is also responsible to the transportation department for furnishing equipment when it is required for the operation of trains.

The mechanical man knows what repairs are necessary on a locomotive or a car and he can estimate very closely the time which will be required to complete them. The transportation man knows the volume of business which must be moved over the division and the amount of power which will be required to move it. Not infrequently, when business is heavy and power is in great demand, the transportation man will call for short turns on the power and will ask for the speeding up of shop repairs. It is the place of the mechanical man to do everything in his power to repair and turn the power quickly, but his is the responsibility if the power so turned fails in service because of neglected or of hastily made repairs.

The Light Brigade at Balaklava charged into the face of the enemy's cannon and was shot to pieces because a blundering officer had ordered it. They were heroes, of course, but their lives were wasted. The mechanical official who subordinates his own judgment to that of the transportation man by sending power out on the road when it is in no condition to go will find himself in the same position as the Light Brigade, all shot to pieces, but no one will call him a hero.

The relations between the departments must be maintained on the basis of good common sense. The mechanical officer is

the judge of when power is ready to go and he should not send it out until it is ready. One engine failure on the line will cost more than many hours of terminal delay and the roundhouse foreman or master mechanic who takes a chance on an engine merely to accommodate a dispatcher or a trainmaster is not performing his duty.

There are a few unreasonable men in the world but the large majority are willing to see the point of a good argument. Very few superintendents or chief dispatchers or trainmasters will insist upon an engine being furnished if the mechanical man will take the trouble to explain just why more time is required.

Most of the trouble between departments occurs because of lack of proper co-operation. The transportation department lays too much stress upon the importance of moving trains from terminals at a given time, while the mechanical department holds out for its regular routine regardless of the needs of the traffic. The efficiently operated division is the one on which the superintendent and the master mechanic, the roundhouse foreman and the chief dispatcher work together in the closest harmony with the single purpose of moving the traffic as expeditiously and as cheaply as possible.

The problems of the mechanical department are many and complex and the man who would rise from the ranks must expect to devote a great deal of time to their mastery. He must not only be a master of the theory and practice of mechanics, but he must understand the handling of men, he must know how to plan and schedule the work of his department, he must know the relation between the activities of the shop and roundhouse and the operation of the road as a whole.

CHAPTER XVIII

SHOP FACILITIES

116. The Importance of the Problem.

The man with the No. 2 shovel will make a very poor showing alongside of a steam shovel, and the more dirt there is to move the less impressive will be the work of the individual equipped with crude tools. The efficiency and sufficiency of shop, enginehouse and car department facilities is a factor of ever increasing importance in railroad operation and the problem is one to which the mechanical department must give constant and competent attention.

This subject can best be introduced by quoting from a paper presented before the Western Society of Engineers by Mr. Paul L. Battey, covering the engineering studies underlying rehabilitation work on the Denver & Rio Grande Western Railroad:

"In these days of high cost of labor and materials as represented in the large investment in equipment units and their maintenance, a comprehensive analysis of all the factors involved in economic operation brings out some phases of the problem, which are rather outstanding, in the light of what has been considered common practice. It is essential that a proper balance between the ever increasing size of locomotives and cars, and the facilities for maintaining and operating this equipment, be constantly in effect. This is further necessitated by the development and use of more intricately designed locomotives and heavier units in both locomotives and cars, in order to minimize the time this expensive equipment is out of service.

"It is this time element which the writer wishes to stress, as the use factor of equipment is determined by it, and after all is said and done, the end of all economies is the highest possible

use of equipment, which simply means keeping it in actual service on the road, and reducing the man hours in maintenance,

“There are several factors involved in getting this result other than that of maintenance facilities, such as traffic and climatic conditions, with respect to which no two railroads are alike.

“Traffic charts have their peaks and depressions and any analysis of maintenance facilities must be made with traffic demands in mind. Frequently advantage may be taken of seasonable fluctuations in traffic in the conduct of maintenance work, resulting in considerable saving in annual costs even though added investment be required.

“The underlying principles governing these problems may be illustrated by the discussion of an analysis recently made for J. H. Young, formerly receiver of the Denver & Rio Grande Western, in order that he could include in his budget for general rehabilitation of the railroad as a whole, the terminal facilities and repair shops for the mechanical department so as to maintain the motive power and car equipment in first class operating condition. The first problem was to ascertain the capital mileage in locomotives and cars as the equipment was found on the system. By capital mileage is meant the total available miles in each locomotive and car until its next general repair. To maintain rolling stock in par condition the same amount of mileage per annum should be restored by the shop facilities except in so far as obsolescence requires the application of more modern and efficient devices.

117. The Locomotive Department.

“The facilities for the locomotive department consist, of course, both in the engine terminals and in the repair shops. Terminal facilities are of great importance under present conditions, both from an operating and from a maintenance standpoint because of the necessity for balanced classified and running repairs, while the repair shops are purely a matter of maintenance, except insofar as they affect the time of equipment in shop.

"Our survey, therefore, included a careful study of the disposition of the power on the several divisions and the particular local requirements of each division, which in this case, was unusually varied because of topographical conditions and the fact that these have required the maintenance of both standard and narrow gauge equipment. Consideration was given to the possibility of longer divisions with the Mountain type engines which have been purchased and the probability of the ultimate electrification of the mountain divisions.

"One important phase of the analysis was the determination of the time each motive power unit was actually in service on the road. The results indicated that condition which is usually found on other roads—that the actual use factor of the motive power unit to the operating department is between 20% and 30%. A careful analysis of the distribution of locomotive hours in this case showed that approximately 65% of the locomotives were serviceable and that the remaining 35% were unserviceable. Of the former 15% were in enginehouses in the hands of the mechanical department, 26% in enginehouses awaiting trains, 3% at terminals and 20% actually on the road or in yard switching service. Of the unserviceable 35%, 5% were waiting repairs, 24% undergoing repairs in shops and enginehouses and 6% set aside as obsolete. These figures reflect the usual condition during the shop strike, for which allowances were made. With, roughly, a \$50,000.00 investment represented in modern motive power units, plain economics demands the provision of adequate facilities for quickly returning an engine to service, including all possible repairs that can be economically made at the terminal in order to keep the engine on the road making its expected mileage before general overhauling. On most roads there are periods of maximum demand for power when this is extremely important; on the other hand there are lulls in traffic, reducing the necessity for quick handling. Evaluation of these opposing factors must be based upon the traffic charts.

"Comprehensive analyses required full information as to the character of assigned engines, engine failures, time required to

turn and to wash boilers, and the numerous other factors involved. It required proper conclusions as to the size of the roundhouses, boiler washing plants, water treatment, capacity and length of turntables and the local repair facilities, all with the purpose of establishing a balanced condition of locomotive operating and repair facilities throughout the system, minimizing the dead engine mileage and the time equipment is out of service.

118. Distribution of Facilities.

"The proper distribution of the mechanical maintenance facilities of a railroad is a matter of increasing importance because of many present-day conditions that were not formerly of so much weight. Decentralization has become almost a necessity because of labor conditions and the high investment represented per unit of equipment. Many years of observation indicate the favorable results of keeping each unit of power in service as long as possible by adequate running repairs before stopping for a general overhauling.

"Consideration of the investment value of equipment with relation to the investment in terminals and local repair facilities, clearly points to the distribution of facilities over the system rather than to provide meager terminal facilities and one or more large general repair shops.

"In the instance of the Rio Grande Western, the outcome of the analysis was the complete rehabilitation of the two principal repair shops located at the extreme termini of the road, at Denver and Salt Lake City, and extensive improvements in the terminal at Grand Junction, probably the most central point on the entire system. In fact, the analysis involved a careful study of the advisability of building an entirely new central repair plant at Grand Junction in lieu of the two existing plants at the east and west ends of the road. But the advantages of this plan were more than offset by disadvantages of greater weight. However, the additions at Grand Junction were located with the idea that comprised the initial move toward the construction of a general repair plant at that point at such time as

the capacity of the shops at Denver and Salt Lake City may be exceeded.

"The terminal facilities were improved by the installation of a new 110-foot, 450-ton, 3-bearing turntable and the lengthening of the roundhouse to take care of the new and larger engines contemplated for operation over the extended division from Denver. New drop pits were installed, together with modern heating and lighting installations. This, in conjunction with a new locomotive repair shop having sufficient capacity and equipment for four heavy engines, including modern tools, a locomotive hoist and crane service, provides for adequate and efficient handling of equipment on the division and makes it possible to realize on the economy of balancing the repair forces throughout the year, as heavier repairs on several engines can be scheduled and carried on at this point, such engines being promptly returned to service.

"Terminal improvements at two other points were also developed. At Salida, Colo., the junction point of the narrow gauge system with the standard gauge main line, the roundhouse and terminal repair facilities were extended, this installation being approximately the same in repair capacity as at Grand Junction, similar equipment being provided. But provision is also made at this point for the handling and repair of narrow gauge engines, the improvements including a new and deeper section to the roundhouse, together with a modern boiler washing plant and a steam heating system.

"At Alamosa, Colo., which is practically the center of gravity of the southern Colorado section of the road and narrow gauge lines, a very fair repair shop was in service, relatively better than at other points on the line. The principal improvements required here to bring the plant up to balanced condition was an extension of the roundhouse with boiler washing and steam heating systems, a longer turntable, a small extension to the repair shops, some new and modern tools and a change to electric drive throughout, with improvements to the power plant. This constituted the betterments to the terminal facilities for

motive power as determined by a careful study of existing and future requirements.

119. *The Tractive Power Mileage Unit.*

"Now as to repair shops for general overhauling of power. The measure of capacity to determine the size of a locomotive shop should be the product of a tractive power unit and the locomotive miles consumed on the road, for the reason that the weighted average of the engine size must be considered with mileage to form a working factor.

"As before mentioned, it is necessary to put into the locomotives by renewals and repairs, the same number of miles that are taken out of them on the road. If, for example, the total annual locomotive miles were 12,000,000 and the average tractive power of all locomotives making this mileage is, say 40,000 pounds or 40 units of 1000 pounds each, the total 'T.P.U.' miles consumed on the road would be 480,000,000.

"To maintain the power in par condition shops must in a year turn out the same number of T.P.U. miles. The measure of their gain or loss over any period of time may readily be ascertained by balancing production and consumption. A formula for arriving at erecting shop capacity may be expressed in the following terms:

$$C = \frac{NDL}{\frac{(MR)}{(MA)} Y}$$

where—

C=Total lineal erecting space.

N=Number of engines tributary to shop.

D=Calendar days in shop.

L=Average length of space allowed per locomotive.

MR=Average T.P.U. mileage between repairs.

MA=Average T.P.U. mileage per locomotive per annum.

Y=Days per year (365).

"This applies to a longitudinal shop, but the formula may be used for a transverse shop by eliminating L and considering

C as the number of pits. Or it may be applied to determine the number of positions, to the horseshoe type of shop. After arriving at the capacity of the shops for normal shops maintenance as at present, a percentage should be added for growth in the size and number of locomotives for a period within which it would be uneconomical to make shop extensions. This additional capacity also provides means of reducing to normal basis the capital mileage deficit at the time of the new shop installation.

“The probable future traffic development as influencing the future extension of new facilities or additional installations at other economical points, should receive consideration as well as the labor market, the source of supply of materials used in repairs and the continuation of existing facilities in so far as this can be economically accomplished, these latter factors being of vital importance with relation to the location of the facilities.

“No two roads have exactly the same conditions affecting the wear of equipment. It is therefore necessary to secure detailed information with regard to the distribution of the equipment, the grades and curvature of the track, and the character of the fuel and water used on various divisions. These, together with the general climatic conditions, largely determine the rate of repairs for machinery and tires as well as boiler and fire box renewals to locomotives. Therefore a careful study of these factors is required in order properly to proportion the departmental relationship of the locomotive repair shops.

“Mere shop capacity as measured in floor space, which in the past has been considered the principal factor of output, has not always been considered at its proper value. From years of observation and contact with the problem, the writer has become convinced that many shops throughout the country have, to some extent, been used simply for storage space for equipment awaiting repairs, or its equivalent, in the extremely low rate of progress of repairs.

“In the case of the present road, it was found that as measured by engine standing space under cover, there was actually more

than necessary under modern shopping methods. The real output capacity of a modern railroad repair shop is dependent upon proper machine tool equipment, crane service and the organization and method of handling equipment through the shops, more than the actual floor space occupied by standing equipment undergoing repairs. The problem on the Denver & Rio Grande Western, so far as locomotive repairs was concerned, was further complicated by the great diversity in the type and size of units, including some very light engines and the largest Mallet and Mountain type engines in use, together with some gear-drive equipment.

"For economy of floor space in housing these engines while under repairs, obviously the most economical type of shop was the longitudinal, and further, this arrangement was necessitated by the requirements of the site in conjunction with existing buildings which it was deemed inadvisable to destroy.

"On the D. & R. G. W., as before mentioned, largely because of diversity of equipment, the locomotive shop was so arranged that the service tracks run parallel with its length, but the routing of the locomotives is such within the shop that a progressive or semi-progressive handling results, which makes possible low unit repair costs in the various departments.

120. The Departmentized Shop.

"The shop is departmentized as far as it is feasible, machine tool groups for the various operations being placed immediately adjacent to the section of the erecting shop where such parts enter the assembly. Thus the wheel department is at the extreme end of the shop adjacent to the unwheeling and wheeling pits and immediately next is located the driving box department and so on. A balcony extending under the machine shop crane so as to be served by it, is provided for the brass department, headlight, electrical and for similar work. The boiler shop is located in the opposite end of the building from the wheel department, but so arranged as to be served by the erecting and machine shop cranes, thus minimizing the movement of boiler work. The result of the departmental relationship is

such as to reduce the lost time in the handling of parts to and from engines undergoing repairs to a minimum with a resulting economy in cost. The modern motive materials coming mostly from the East, it is evident that a manufacturing department located at Denver shop at the eastern terminus of the system would be an economical provision, parts produced here to be distributed over the system through the stores department. This has proved a successful innovation.

"Because of the necessity of maintaining operation of the existing shops at both Denver and Salt Lake City, through the rehabilitation period, it was necessary to predetermine a schedule of operations, placing the various improvements in their proper sequence to secure a minimum of interference with the regular operation of the shops. This was carried out as planned in an entirely successful manner, the plants as finally rebuilt being completed, including the making the plans for same, within a year.

"The detailed design of the new locomotive repair shops was, of course, complicated by the presence of the existing structures. At Denver provision for a new locomotive erecting, machine and boiler shop released the old locomotive shop for use as a blacksmith shop, the old shop being razed, together with a number of minor structures after the erection of the new shop. It also released a large section of the roundhouse which was of concrete construction, provided with overhead traveling crane and used for an erecting shop, several stalls in the end, however, being retained for a tank shop where they could be served jointly with the boiler and machine shop by means of an outside yard crane.

121. Car Repair Work.

"The requirements of the passenger car department, as determined by analysis, were such that no material increase in facilities were required, and therefore improvements in this department were nominal and confined to the changing of some features which increased the output of existing buildings, such as a new electrically operated transfer table at the Denver shop. This,

however, is utilized in connection with the new facilities for freight car repairs, it thereby serving a double purpose.

"In approaching the problem of freight car repairs, a number of factors were taken into consideration, which apparently have not been given full weight in the past, the outstanding one being the relation of the total cost of freight car repairs to the cost of motive power repairs, in this case the cost of freight car repairs being the larger. A comparative analysis of many other roads in the country shows much the same relationship, in some instances cost of freight car repairs being considerably in excess of the cost of motive power repairs, and in others about equal to or slightly less.

"For many years it has been the writer's belief that the railroads have failed to take advantage of the large saving which can easily be accomplished in the conduct of car repairs, not only from the standpoint of reduction of man hours required, but with the highly important advantage of reducing the days out of service to a fraction of what has been countenanced in the past. In approaching the problem of freight car repair facilities on the D. & R. G. W. and having made analysis of the factors contributing to the requirements for such, we gave full weight to the advantage of providing real repair shops, rather than extending the rip tracks. Here again, the measure of shop capacity is not mere standing space. Our conception of the problem centered around an entirely new plan of operation, and now that the shops have been completed and in service for several months they show a reduction of one-third in man hours. This is based on a recent statement of T. H. Beacom, the receiver, and shows that our original estimate of 25 per cent had been exceeded to this extent. The bettered conditions have brought about a state of mind on the part of the employees almost unique in freight car repair departments.

"It is plain that in order to do a given amount of work upon a car in the least possible time, it is advantageous to work as many men as can be used efficiently. To accomplish this it was necessary to assign the men as far as possible to particular tasks and to arrange for handling of material to the men in

such a manner as to keep it out of the way and yet have it immediately at hand as required.

"Under these conditions it is easily possible to increase the number of men per car from 1 or $1\frac{1}{2}$ commonly employed under the old methods to 6 or 8 men, clearing the car for service in proportionally less time. Where the shops are relatively small and well distributed over the system, advantage can be taken by developing an esprit de corps, which has been lost in our large modern organizations. Both economy and interest are introduced where duplicate assembly lines are provided in the layout of the shop; first in the ability to reduce shop capacity 50 per cent without in any way affecting the maximum economy of operation; and the second in the possibility of friendly competition between parallel gangs which adds zest to the work.

"The problem of transporting materials, including supplies, from the storehouse in connection with freight car repair department is as important as that of the locomotive shops. Here it involves greater distances and the interference of numerous tracks and in order to obtain maximum flexibility of the transportation units, the tractor and crane truck delivery system with well conditioned roadways is essential. In this instance, a regular delivery system was installed with convenient receiving stations in each department and suitable bins and racks located at each work station. In order to leave the main floor of the freight car repair shop as free as possible for the under-structure work, a second floor or series of upper decks connected by counter-balanced bridges served by outside elevators, was installed, thus making possible deliveries direct to the work stations on the upper deck. All materials going into the superstructures, roofs, doors, running boards and other fixtures are handled conveniently from above. Here also the supplies are racked or binned immediately at hand for the specialized gangs.

"The arrangement of the work in progressive movement from stripping to stenciling eliminates much interference from cross travel of both men and materials, and this together with the organization of the men into special groups markedly reduces the opportunity for accidents.

"Car repairs, even though the units are scheduled in advance in classified groups, necessarily involve an element of variability inherently adverse to station-to-station methods as so successfully applied by manufacturing concerns. But by the provision of floating or balancing gangs of picked men chosen for their versatility on all classes of car repair work it is possible to approach the results obtained by manufacturers. The scheduling of cars entering shops and ordering all materials required well in advance based on careful inspection is absolutely necessary to realize the best results from this method of conducting car repairs.

"An important phase of the design of locomotive and car repair plants and including engine terminals to a measurable extent is a carefully conceived stores department and delivery system. Millions of hours of skilled mechanics' time have been squandered in frequent trips from the work station to the stores department for materials or tools, and this can be saved almost entirely by a comprehensive and adequate system of delivery from the storehouse or yard to the receiving stations in the various departments. Modern trucks and tractors, of varied design suitable for many applications, are available and make possible the entire elimination of the old-fashioned industrial track and pushcar means of transportation still largely used in shop plants.

"Standardization of both materials and tools greatly enhances the possible savings under a delivery system, and in connection with standardization attention should be drawn to the problem of handling the manufacturing for stores department, to the end of balancing the savings in quantity production cost against the carrying charges on stock, as this is the limit to which lot orders can be extended.

"It will be noted that costs as related to the various factors of analysis have not been touched upon; this for the reason that costs always vary with local conditions and, therefore, mean little except in the light of these conditions. Cost factors are, of course, determined in every way possible and are utilized in any analysis as to the design of facilities, but these, as well as

practically all factors in the problem, must be applied with a broad background of experience to arrive at a practical conclusion. With many variables and empirical assumptions to deal with, experience is the guide to results. In the present instance it can be said that while the improvement program was predicated upon an estimated investment return of 20 per cent, Mr. Beacom has recently stated that results are measurably better than estimated. This in part, no doubt, is due to the increased efficiency of the organization he has been developing.

"The extent of return upon investment is the full measure of accomplishment. Any program undertaken should be based upon a sound relation between investment in equipment and in maintenance facilities, and always with adequate service assured."

This analysis of rehabilitation work carried out on the Denver & Rio Grande Western is introduced to give the student an idea as to the processes which are followed in working out the problem of equipment repair facilities. In the case of the D. & R. G. W. the road was bankrupt, and for a number of years had not been able to earn sufficient income above operating expenses to pay the interest on its bonds. The bankers, who have been endeavoring to rehabilitate the road so that it might be self-supporting, realized that improved facilities were necessary before operating costs could be so reduced as to provide a margin of profit, and the program just described was one of the means taken to secure this result.

It should not be understood that all of the opinions expressed in the quoted article are indorsed as outlining the best methods of reducing equipment repair costs. The problem is different on every railroad, and schemes which were effective on the D. & R. G. W. might not work out so well on another road.

CHAPTER XIX

EFFECTIVE CAR DEPT. SERVICE

122. The Importance of the Car Department.

On the average railroad the money expended for car repairs exceeds that spent for locomotive repairs. The locomotive is a more impressive piece of machinery than is the car, but on the whole it is a no more important factor of the transportation system. The humble box car has, perhaps, not received the attention from the general officials of the railroads to which its value entitles it, indicated by the fact that car repair facilities, generally speaking, are not so up-to-date and efficient as are the shops and equipment provided for overhauling locomotives.

The attention of railroad managements has been forcibly called to the importance of the freight car during recent years by the shortage of such equipment which occurs at seasons every year and which limits the earning power of the carriers. It is not so much a shortage of freight carrying equipment which has embarrassed the railroads during periods of heavy traffic as the impossibility of keeping the cars in service. This condition has been partly due to the inadequacy of freight car repair facilities, partly to lack of adequate method in the completion of repairs and partly to unnecessarily slow movement of cars on line. All of these matters are now receiving far more attention than they have in the past, and a substantial improvement in freight car performance is to be expected in the future.

An analysis of the freight car service problem by a man who is in a position to know should be of interest and profit to all mechanical executives, and particularly to those whose duties make them in any way responsible for the operation of the car department. The following abstract of a paper read by Mr. L. K. Silcox, General Superintendent of Motive Power, Chicago,

Milwaukee & St. Paul, contains information which will be of value to every mechanical department executive:

"Service, such as implied in the title of this address, is dependent on an adequate organization, properly selected, adequately directed and constantly followed up. The elements involved are both human and material. In the first place, it is understood that each administration has its problems presented in a way peculiar to itself, so that any suggestions for change ought to be carefully weighed and, if found at all desirable, modified or improved upon to fit the actual condition in mind, then woven into the policies already obtaining, to the extent found most favorable to an enlargement and betterment of existing methods. Changes are hardly ever profitable if hastily carried out; confusing and distrusted if time is not taken to consult with and receive suggestions from those directly affected.

"A great deal of pressure is brought to bear from certain sections for even larger management units than we now have, and yet the dangers of such a move are not often thought of and even less evidently expressed. There are those who urge more extensive railroad grouping, those who feel that all of the freight cars in the country should be constructed, operated and maintained by one single organization, and quite a number of other propositions similar in purpose, which are brought to attention from time to time. It is important in every circumstance where judgment must be passed to seek fundamental facts and principles. The aim should be, in any event, to preserve the personal equation and if large management groups can be so skillfully conducted as to meet this need, much of possible danger is avoided. Again, attention is directed to the thought that in any endeavor where individual initiative is lacking or conditions make the exercise of it unimportant, we are sure to travel in a negative direction. Competition is a necessity either in business or for a healthy sense of personal merit.

"The one great thing that keeps the railroad service of our country to the present standard it has attained, even though some properties are not able to operate on a paying basis, is the element of attainment; still the public reaps the benefit. There

is a fact to be reckoned with in our daily life as railroad men which cannot be expressed in dollars and cents. It is given freely, whole-heartedly and constantly—an ever-living pride in the operation of the railroad each of us may be privileged to serve. I hesitate to bring so much data from the administration I am connected with, but if it is accepted as a few leaves from our book of experience and never in the sense of self-satisfaction, I shall feel some good has been done. In addition let me say that such presentation as is made should be credited to the faithful support accorded by my associates.

123. Car Design.

“It is necessary to adapt the question of car design to service (regardless of territory) with the object of having equipment which will give a maximum of return with a minimum of delay because of not being in the proper condition. The question of car design is ever progressing, in that there is a rather constant advance in the methods of operation as well as universal and interchangeable use, which must be kept pace with in the design of equipment. For the past fifteen years there has been a considerable increase in the size and tractive force of locomotives in order to meet the demand for larger individual trains and thus reduce the unit cost of train and engine crew expense per ton mile. This has brought about a demand for freight equipment which will meet the changing conditions so that there has been a very marked enlargement in thought regarding the matter of strengthening parts, especially in the body bracing, underframing, draft members, etc. In common with other carriers our experience shows that these conditions generally develop into a demand for a plan of work or a program of improvements to freight cars such as will cause the major portion of ownership to be universally acceptable as to strength requirements and protect the owning road in current maintenance expenses. For this purpose an analysis of the equipment owned with a view to determining that which has not been giving the proper service or which could not be brought up to operating demands is imperative and can usually be divided into:

“(1) Those cars built of recent years which are of such design as to practically meet present conditions with maximum service.

“(2) Those cars which have been built prior to the operating change referred to, but which could not be dismantled consistently because of age, general design and capacity and, therefore, which can be made subject to a special improvement program on the basis of a study of physical characteristics.

“(3) Those cars which because of age, capacity, design and condition are not considered fit to be improved and, therefore, can be run until worn out and then dismantled.

“The second item was found to embrace from 25 to 35 per cent of the total equipment in our case, and was affected by the policy of the carrier, for some twenty years previous, as to the rate of turnover in acquiring new and retiring old equipment.

124. Improvement Program.

“It can be said, in general, where there has been a steady and accurate retirement program with an acquisition factor designed to offset the same, that it forms one of the easiest methods of overcoming obsolescence in design, but where retirements have been deferred with a consequent lack of new equipment acquired, the problem of overcoming obsolescence or the inherent design of equipment which does not permit of maximum service, is one involving large proportions and a great deal of expense when a change in policy is forced by reason of expanding service demands. Such a condition usually requires years to overcome. It is necessary to analyze each series of cars and determine what improvements or changes are required to make them fit for maximum service, then to work out a bill of material and labor schedule for each and determine the total cost. As a matter of convenience this plan is easily followed if each class of car is given a schedule number, the schedule representing the bill of material and amount of work to be done.

"A program of this kind involves the selection of car shops best adapted to each kind of work with a corresponding organization of forces, stock of materials, shop facilities, etc. The location of shops in the vicinity of loading stations is a factor of importance with respect to economy in transportation. Considerable supervision of such work is required to see that material is at hand to keep forces fully employed and that the work is done as prescribed and the output is at the proper rate. It is possible to set up a definite output based on a specific number of men allotted for the work at each point and then keep a definite record of the work done so that the status of same may be known at all times. [See Reports in Appendix.]

"In any such plan there is, of course, a great deal of heavy work done in the nature of repairs in kind and in many cases it can be determined by estimates before the work is done, whether or not it will constitute rebuilding as prescribed by the accounting method or will be considered as heavy repairs with certain charges to capital account for improvements. This is merely another expression of the fact that obsolescence is overcome to the degree that equipment when reinforced to meet present-day strength requirements is accounted for in the books as new and the expected life cycle will be relatively extended. Freight car repairs, if carried on so as to give maximum car service at a minimum cost, usually result in dividing the work into two groups; that is, the repairs which must be made at certain frequent intervals to overcome wear of certain parts, and repairs which are naturally accumulated until the heavy repair cycle is at hand. All carriers renew, by force of circumstances, such items as wheels, axles, brake shoes, brasses, air hose, couplers, etc., in their proper cycle between heavy repairs to the entire car. This is a natural sequence, if maximum service is to be obtained with a minimum repair cost and at the same time having the situation in control as to developments which require further improvements.

"The turnover of equipment both in the matter of retirements, acquisition, rebuilding and heavy repairs is a most important feature in developing car repair programs and especially

in determining the policy to be pursued after an analysis along this line has been made. For instance, the average age of equipment owned, while a vital factor in the proper knowledge of the repair situation, has not, for the most part, accurately reflected conditions as to requirements of policy with respect to physical factors on such roads as are subject to Interstate Commerce Commission accounting rules, as was the case prior to 1914.

"In that year the I. C. C. issued a classification of accounts, providing that the rebuilding of equipment in cases where the cost of the work constituted the major portion of the value be considered as renewed, and as this required calling equipment new under such circumstances, the life cycle was for this reason begun anew. This changed the situation considerably in the case of some administrations from their former practice, because prior to that time the life cycle of the car continued from the original date built regardless of the nature of the ensuing repairs or improvements and it was entirely optional with the owner whether or not it would be considered that cars were dismantled and used in the building up of new equipment or whether the original unit would be continued, as such, regardless of the work done.

"The requirements of the Interstate Commerce Commission classification covering rebuilding made it possible for those who elected to do so to adopt a policy of refinancing and reconditioning equipment out of operating expenses in the first instance, with a consequent adjustment of accounts and transfer of proper charges to capital account, all of which has generally been affected by the operating ratio as a determining factor in the extent to which the rebuilding of equipment could be carried out.

"In recent years, however, it has been found that other administrations have been able to borrow money on the new valuation of the rebuilt equipment because, presumably, they could not bear the operating charge in the first place, even though this would eventually be credited to operating expenses and charged to capital.

"The extent to which rebuilding and heavy repair work is carried on is important. Heavy repair work can be reduced to a formula so far as requirements are concerned when an analysis is made of equipment to determine its physical characteristics on a broad scale and then set up the heavy repair cycles. These cycles run from 8 to 12 years, depending upon the characteristics of the equipment. If a carrier owning 100,000 cars has had a turnover of rebuilding and heavy repairs at the rate of 10,000 per year, then it is apparent that the general overhauling cycle runs 10 years. A more detailed analysis will doubtless develop certain cars requiring renewal cycles of 8 years, others considerably more than that. The idea here is that a close regulation of the nature of repairs and, therefore, the general maintenance cost will finally resolve itself down to what is now being done in the case of locomotives, where there is a constant analysis required to determine the proper balance between running and classified repairs based upon many considerations, one of which might be pointed out here as being the miles run out and the miles restored in classified repairs. In the case of freight cars, years may be substituted for miles, considering years run out and years restored by overhauling. Much can be done along the lines of determining frequency of heavy repairs in further detail by records showing how this is progressing by types or series of cars. Returning again to the example of a road having 100,000 units, it is possible to have a division as follows:

Cars	Age	
10,000 at	2 years	20,000
15,000 "	5 "	75,000
10,000 "	8 "	80,000
20,000 "	10 "	200,000
10,000 "	18 "	180,000
5,000 "	20 "	100,000
10,000 "	25 "	250,000
10,000 "	26 "	260,000
10,000 "	27 "	270,000

"The policy of heavy repairs and rebuilding the past 10 years shows the average yearly number of cars so overhauled at 5,000 a year, or once every 20 years. The new program will require, after an analysis of equipment, an average of 9 years between heavy work, so that the program will have to be increased to 11,111 cars per year, of which 5,000 will be rebuilt and thus renew the life cycle, and reduce the average life gradually to approximately 10 years, if the usual 20-year life is to be maintained.

"But if an acquisition program is followed consistent with ownership, then there will be 5,000 cars retired and 5,000 new cars purchased, which will reduce the requirements for rebuilding to less than 11,111 cars, because of reducing the average age thereby. In the latter plan there will be an approach to the average age of 10 years, but further analysis will be required to determine the extent of heavy work to be done to prevent the overhauling of obsolete cars to maintain the proper ownership complement.

"It may be of interest to note further that the extent to which this kind of work can be transferred to capital charges is not always simply governed by the physical valuation in relation to capital investment, but as before stated, by the operating ratio, which is another way of stating that the amount of property required to perform the service is not, in every instance, the only factor, but the density of traffic as a whole or the volume handled which justifies building up capital out of operating expenses on the one hand, and direct capital charges by means of acquisition of new equipment on the other hand.

"Features of this nature must be known and analyzed if a further and proper regulation of equipment is to be had consistent with local conditions, and any study will reveal the fact that at the present time there appears to be some difference of policy between carriers in this respect. Therefore, it is not possible to express specifically a general plan for common use. This is one of the reasons why the situation is not yet propitious for the central control of all the equipment in the country as a whole. Whether desirable or not, it will be many years before

this problem can be fully solved and brought to a state of uniformity throughout the country. What makes this question of such great importance is that the maintenance of freight cars involves not only repairs, but includes charges for depreciation on the investment in existing cars and retirement charges (or deferred depreciation) involved in cars taken out of service. This is one of the cases in railroad accounting where maintenance carries the burden of investment, the only item eliminated being interest on the investment, which is a fixed charge not included in maintenance.

"While a schedule of improvements is an essential feature of any railroad policy in order to meet changing conditions in operation, there are other factors in the ordinary maintenance of equipment, such as painting programs, special attention to refrigerator equipment, repairs and inspection to permit selection of cars for special loading, so that loads may move to destination without interruption, etc. In order to follow up a maintenance policy closely and have it regulated in accordance with what the revenues will permit, it is necessary to be able to decrease or increase special program work accordingly and also regulate other plans in maintenance policy such as inspection, light repairs, etc.

"Freight car inspection can be organized and classified so as to reduce the method of reporting thereof to a system rather complicated in itself, because carriers are not only concerned with their own repair policies, but must inspect both system and foreign cars for safe movement in trains whether the load originates on home or foreign lines.

"There should be a clear understanding in the matter of inspection as to what it means to 'bad order' cars, and have them switched to repair tracks in cases where it would be possible to make repairs in the train yard. Switching is expensive and should be conserved, even though it is not charged to freight car repairs. Much can be done to save this expense and expedite the movement if handled in train yards.

"While all that has been said relates to action which may be taken by car department employees, the element of possible

loss to the service from lack of attention to avoiding cases of rough handling, cornering of cars, failure to release air brakes in making stops prior to taking siding for an opposing train, resulting in pulling out drawbars, and delaying both movements, etc., such losses may be avoided by proper co-operation and adequate appreciation in working out a plan in any given instance, for it is evident to most car men that losses of this character occur too frequently and that they are not sufficiently enumerated. A poor crew can generally manage to set out a few cars each day or burn off a journal occasionally, while it takes a wideawake and experienced train crew to treat boxes in such a way as to bring all of their cars safely into the terminal and save fuel in seeing that side doors of box cars, when picked up, are properly closed, not leaving the job entirely up to the other fellow or even overstraining themselves in these acts of constructive helpfulness.

“Laxity in practice has resulted from technicalities being applied, such as car men being called, in many cases unnecessarily, to couple hose, incurring expense entirely out of proportion to the work thus performed and which, for the most part, seemingly could not originally have been anticipated or even implied in the formulation of schedule rules. I recall a condition resulting from orders being issued requiring car men to scrub out cabooses, which resulted in the men involved seeking information as to the possibility of eventually being assigned to ‘red cap’ duty in train yards. While the thought expressed may seem remote, it clearly indicates the trend of mind on the part of car men who may be diligently applying their efforts in the interests of the service.”

CHAPTER XX

THE CAR DEPARTMENT

125. A. R. A. Rules.

In continuing the discussion of car department problems further use will be made of the paper quoted in the previous chapter. Mr. Silcox has a thorough understanding of his subject and the specific references which he makes should aid the student in applying knowledge gained to the proper solution of his problems.

“Work coming under A. R. A. rules is of such large proportions that the importance of systematizing and organizing the work is very apparent to all concerned. In the past, much of the billing work consisted in transcribing records of various kinds on to the A. R. A. billing card, resulting in mistakes and misinterpretations because the transcribing was usually done by clerks who did not understand the work. At the larger points where many men are engaged and much foreign line work is done, it is possible to reduce the transcribing very materially by using the A. R. A. billing repair card as the regular record, having it filled in by the car man or checked at the work and forwarding it to the central billing office for the usual collection. It is necessary to have what is termed the original record, which is to be filed at the point where the work was done and it is considered that this requirement is met by keeping a carbon copy of the A. R. A. billing card at the local points for this purpose.

“The method of recording material applied to freight cars differs greatly on the various railroads. Some charge material used from the slips made for drawing material, whereas others charge out the material from records of work done on the car. In the case of foreign car repairs it is possible to use the billing

repair card when material is charged out as applied instead of as drawn, in case the latter method is used.

126. Education of Car Men.

"The education of inspectors, checkers, repair men, etc., employed in handling foreign car repairs, should be followed closely and traveling inspectors are found to be of very great importance in the proper handling of this work. Periodical bulletins should be issued from time to time showing recent interpretations of the rules and also giving answers to all questions submitted to the central office by inspectors.

127. Bad Order Car Report.

"The practice of following up the bad order car situation is now practically the same throughout the country, the difference being only as to the matter of form and application of the data. This involves the question of classification and organization to handle the work and control the bad order situation. For the purpose of simplifying the matter, repair points can be classified, each having a stated output requirement based on the classes of heavy and light repair work handled. On the Chicago, Milwaukee & St. Paul, Class One repair points are those having one hundred men or more with facilities to handle heavy and schedule work at a specified maximum output; Class Two repair points are those with facilities for doing some heavy repair work, having no less than fifteen repair men engaged in this work; Class Three repair points are those having some facilities and less than fifteen men engaged in repair work; Class Four repair points are those stations of a lighter nature not included in the above.

"The daily bad order freight car report shows by kinds of cars the repairs made each day and the bad order cars left on hand together with the number of men engaged on car repair work. This daily report is sent to the central office for consolidation. In addition to the daily report a special statement is made each month showing all bad order cars on hand at the end of the month by individual car numbers, initials, date

bad ordered, principal defects and date expected out. The purpose of this form is to determine unnecessary or unusual delays to individual cars and to select those which have been held thirty days or more, to see what can be done to overcome such delays. This report is of great value in following up per diem charges and releasing cars in time of shortage.

"The blank back of the daily bad order report is used for special information and one of the features is a report of personal injuries occurring each day. Personal injuries are followed up closely and recorded in relation to the turnover of labor to see whether it is due to new employees or lack of safety measures, methods of handling work, etc. It is felt that in following up such matters the local foremen are placed in a position where they must naturally assume more responsibility along this line and keep injuries down to a minimum.

"On the back of this report is also shown a statement of material shortage confined to that which is handicapping the work. This shows the requisition number, the date ordered, the follow-ups, etc., with a view to assisting the general officers in overcoming the situation.

"A car department handbook is issued from time to time designed to embrace practically all of the activities in the handling of car work which come up from day to day and which are more or less standard.

128. Passenger Car Cleaning.

"In the matter of cleaning passenger cars, it is natural to suppose that this is a subject of a minor nature requiring no special records or supervision, but owing to the fact that the Chicago, Milwaukee & St. Paul owns and operates sleeping cars this requires a definite division of the cost as between departments and we have felt it necessary to go into this feature rather closely. The cost of cleaning passenger cars is charged to three different accounts, and the cost of cleaning business cars is charged to still different accounts. The outside cleaning of all passenger cars, except business cars, and the inside cleaning of all except sleepers, diners and business cars, is chargeable

to account 402. The inside cleaning of sleepers is chargeable to account 403 and the inside cleaning of diners is chargeable to 441. The cost of cleaning special or officers' cars should be lodged against the proper superintendence account. This is a rather complicated procedure and as the direct cost of this work is combined with a multitude of other kinds of charges, it is not possible to control the expense without dividing these accounts and determining the direct labor and material charges and the amounts allocated in spreading the overhead charges.

"It is possible to analyze actual individual train operation to control this expense by means of direct labor cost, but this is not always available as the information is based on a variety of data, which is not the same at all times and a mere control of the direct labor feature does not give any idea of the correctness of other allocated charges.

"In order to follow up the cleaning cost properly it is necessary to have organization and classification. We are handling it upon a basis of inside and outside cleaning and a classification of equipment according to the division in the accounts. The classes of cleaning are divided as follows:

- "(A) Outside cleaning when car is scrubbed with water and acid and trucks scraped with distillate.
- "(B) Outside cleaning when car is scrubbed with water only and trucks cleaned with or without oil spray.
- "(C) Inside cleaning when car is sponged with soap and water and otherwise renovated.
- "(D) Inside cleaning when car is blown out, swept, dusted and mopped.
- "(E) Light cleaning of inside while enroute.

"The classification of cars for making the proper division of the cleaning cost to the appropriate account is as follows:

- "(1) Diners and cafe-observation cars.
- "(2) Sleeping, tourist, compartment sleepers and observation sleepers.
- "(3) Business cars.
- "(4) All other passenger train cars.

"The instructions provide that cafe-observation cars count as diners and that the inside cleaning cost shall be divided so that 60 per cent goes to account 441 and 40 per cent to 402, this division being based on average dimensions. A division of the charge for inside cleaning of observation sleepers provides for 30 per cent against 402 and 70 per cent against 403. Charges for business cars depend upon the account of superintendence to which the officers' pay is charged. Charges for all other work on ordinary cars goes to account 402.

"It might appear that this is too much detail, but it is as yet an experiment and is lined up something in the same manner as we handle enginehouse expenses. It is possible to make an entry of all operations each day in the month and then to use the same form for a monthly summary of the system. The summary at once gives us the total charge against the various accounts for cleaning cars and when the difference between the direct charge and the total charge as made up by the accountant is too great, a further analysis is made to determine the reason. This form covers both labor and material, but does not provide for the usual overheads allocated by the accountant, such as store expense, shop expense, power plant distribution, bills and vouchers, etc. This is merely another illustration of intensive supervision of a certain class of work which cannot be fully controlled by other means.

129. Hiring Men.

"The personnel, comprising labor forces, reflects the intelligence exemplified by the employing officer when selecting new men for the service. In some cases there are periods when he may be restricted from making his judgment effective in the selection of his men, such as we witnessed during the late war when labor shortage was tremendous and we were compelled, in many instances, to accept men who, under ordinary circumstances, would not meet the requirements. There are other times such as when forces are to be increased immediately for emergency service. This causes the average foreman to overlook the importance of knowing what kind of a man he is hiring.

In every instance when conditions permit, the objective should be to secure the best available talent. The management must always have this thought in mind when issuing instructions to increase forces.

"Much can be accomplished, when large numbers of men are employed, by arranging for permanent forces, which results in steady employment to a sufficient number of men to take care of the service adequately. Emergency cases and fluctuations in business can be taken care of by temporary forces, and, if hired as such, it will give the employing officer an opportunity of selecting the best material to be assigned to the regular forces when vacancies occur.

130. Advancement of Men.

"Proper care having been taken in the selection of men for the service, it then becomes important that they receive the right training so to develop whatever natural qualifications they may have for future advancement. Car foremen who are alert will quickly discover these traits and will endeavor to perfect their development, resulting in highly competent men being available for positions that require special skill or unusual attention on the part of the workmen. Such men should be gradually worked into the organization in the various positions for which their natural qualifications adapt them.

"The great need in industry today is to develop employment that has an incentive for the employee voluntarily to do his utmost instead of being merely on the job. In many instances large employers have, at very heavy expense, provided departments to carry out well planned activities of interest to the welfare of their employees and often the results have proved a good investment. These plans are adaptable where the points of employment are confined to comparatively small territory. On railroads, employment is maintained every hour in the day, each day in the year, over thousands of miles, covering in many instances several states, making it practically impossible to follow such a plan, even though it were adapted to their needs. Therefore, of necessity, use should be made of other methods so

that the average man will aspire to do his utmost in the interest of the service. To bring this about, it has been suggested that the following outline be striven for: (1) steady employment; (2) clean and sanitary housing conditions; (3) educational facilities; (4) a correct and complete understanding of company objectives.

"The proper cultivation of human relations is equally important and mutually desirable in providing an incentive for employees to advance in the service. Every officer should feel that he really exemplifies the spirit in which the management is to be accepted by the rank and file. The foreman, in this connection, by his every act, reflects the policy and desires of the management, and, if they are cordially and humanly applied, it will establish a mutual understanding that develops conditions which instill in the hearts and minds of the men the desire to succeed.

"Too often supervisors, and the management as well, lose sight of these essentials which are so eminently necessary to enlist the undivided support and loyal feeling which results in the men liking their work. Once this is accomplished, the way is cleared to perfect an organization among the men, who can function in units, that will provide successful accomplishment. Capable foremen readily acquire the ability to observe men who have this incentive and who, by their efforts, show distinct evidence of being willing and able to secure greater knowledge of the service and assume the added responsibilities involved in the discharge of the duties in each instance where men are advanced to more important positions. Men of this caliber must always be kept in mind and properly trained so that, eventually, they may be able to understand the fundamentals in connection with handling men, and, when vacancies in supervisory positions occur, they should be filled by those whose service merits such promotion. If properly handled, advancement will generally meet with the approval of the rank and file, and be further evidence that there exists an opportunity for them to do likewise, if they will fit themselves and be ready, at all times, to meet service requirements."

131. Discipline.

"The administration of discipline is in itself an act of judgment on the part of the management. No well directed property can function efficiently until the subject of discipline has been thoroughly studied and a definite policy inaugurated, because discipline can rightfully be construed as constructive criticism. Each property has its individual problems to meet and in applying discipline to employees it should be done with a sense of justice that will be eminently apparent to those involved. Sentiment and personal favors must be entirely eliminated. Honesty, and a willingness to define the facts, should at all times prevail in order to eliminate the greatest evil in the application of discipline, which is discrimination. It is practically impossible to apply constructive discipline in any line of industry where there is a large labor turnover.

"Foremen are apt to apply discipline under pressure by removing men from service for causes which when investigated are not substantiated by fact, resulting in their judgment having to be suspended by higher authority, and the employees involved returned to service. Action of this kind often causes the foreman to feel that he has not been properly supported, resulting in his becoming indifferent as to the action necessary in subsequent cases.

"Care should be exercised to impress each supervisor with the necessity of applying the principles above referred to in each case and profit by the judgment of his superiors because the details differ materially in almost every case where discipline should be applied. On the other hand, when cases are appealed to higher authority, decision must be rendered in support of the foreman where the facts and policy of the management warrant the action taken. Then if leniency is to be applied, the employee involved should so understand and the foreman be informed so that he will appreciate his duty when other or similar cases arise.

"If these few facts in connection with discipline are truly observed and applied in harmony with existing conditions, a

reduction in labor turnover will be readily evidenced. Close observers realize the tremendous expense, many times avoidable, due to the unnecessary changing of labor forces. If an employee is to be dismissed, it should be apparent that the service is thereby benefitted. Very frequently employees are taken out of service and the new men assigned prove inferior, which clearly indicates that it would be an advantage to the railroad to have kept the employee in service, especially if a method could be employed that would eliminate any undesirable characteristics that he may have acquired.

"In this respect there is an element worthy of consideration. We appreciate, I am sure, that there are men who are objectionable and a detriment, and of course they should in some way be dealt with and definitely removed, care being taken that they do not re-enter the service at some other point without satisfying the management of their intention and desire to function so that their employment will be acceptable and of interest to the service. Discipline resolves itself into a feature of management, which must be comprehended, but never compromised.

"In closing allow me to suggest a few seemingly important items, as a matter of illustration, to indicate the meaning of effective car department service and which embrace:

"(A) An organization with fixed ideals of attainment, working together toward the accomplishment of that end and with the right sense and exercise of the importance of individual initiative and responsibility.

"(B) The proper contribution toward safe and prompt train performance by obtaining maximum mileage per car per year with a minimum of detention enroute due to inspection, physical defects or damage to lading, and at a minimum cost."

The latter part of this quotation from Mr. Sillcox's paper has to do with a subject which is handled more at length in other sections of this course, but the text is included here because it was an essential part of the discussion of car department

affairs, and further because the importance of the subject justifies repetition. The views of a man who is in active charge of a large railroad mechanical organization are always interesting and instructive and their value is enhanced by the position and experience of the man who voices them.

CHAPTER XXI

THE GENERAL OFFICERS

132. Knowledge Is Power.

Political jobs sometimes go to men who are little fitted for them. There is a story told of an ignorant ward heeler who was made a county judge because of his usefulness in lining up the voters of his ward. On this man's first day on the bench a jury case was heard in his court. The judge got along very well by merely keeping silent while the witnesses were being examined and the arguments presented by the lawyers for the prosecution and the defense. But when the last plea had been made, counsel and jurors turned to the judge for instructions.

The clerk of the court, seeing his superior's embarrassment, whispered in his ear, "Charge the jury, your honor." The judge's face cleared and he turned to the jury box: "Well, boys, it's been a long hard day, so I'll only charge you one dollar apiece."

Ignorance does not seem to keep men out of political office, in fact, it sometimes seems to help them in; but no man ever got anywhere on a railroad through lack of knowledge. All the way up the line, from the gang foreman to the president, the men who hold the executive positions are those who have proven that they possessed superior ability and knowledge. The ambitious man in the ranks should know what will be expected of him when he rises to the higher positions, and as there is no limit to the heights to which any man of energy and persistence may aspire this chapter is written to outline the duties and responsibilities of the higher officers in the management, so as to give the aspirant an idea as to the kind of knowledge which will be useful to him.

133. The President.

In the early history of the railroads the president was frequently a man chosen for his financial ability and not for his knowledge of actual railroad operation but this is no longer the case. When the great railroads were under construction there was very good reason for placing a banker at the head of the organization as, at that time, the most important problem was the accumulation of funds to finance the venture, and no one is better fitted to raise money than is the head of a large bank or trust company. At the present time the problem of the railroads is almost entirely one of operation and for that reason it is very essential that the chief of the organization be well equipped with experience in and knowledge of the actual operating features.

The fact that the president of a modern railroad should be a competent operating man does not mean, however, that he has not great need for knowledge of finance and business administration. The capitalization of the railroads is counted in billions of dollars and their revenues and expenses in hundreds of millions. The margin of profit from operation, even on the more prosperous lines, is a small percentage of the money invested and of the amounts received and expended, so that a thorough and intimate knowledge of business finance is necessary to successfully guide the administrative policies.

The president of a railroad is responsible to the stockholders and the bondholders for the proper management of the business and there is no one in the organization upon whom he may shift the blame for failure to make the venture a financial success. While the president of a great system has little time to devote to the actual supervision of operating details, it is his duty to select competent officers to run the railroad and it is his responsibility if the men chosen fail to deliver.

It may be said, then, that the president's first duty is to select a competent staff of operating officers. This is by no means a simple task. Men of superior ability are always in demand and the supply is strictly limited. Railroad salaries

in the higher grades of the organization have not been as high as in other branches of industry and many of the best men raised on the railroads have drifted into other lines. It is sometimes possible to lure a good officer away from some other railroad but usually the president must educate and develop his own men. The successful railroad president must, then, be a first-class organizer. It may be said, in fact, that the men who rise to the highest positions in any industry are those who have the ability to judge the capacity of men, and to handle them in such a way as to bring out their full ability.

A railroad organization is a great machine, composed of human units, each with a definite function to perform, and like the engine there must be a firm and steady hand at the throttle. The president is the engineer of the railroad organization and the efficiency with which the machine functions will depend largely upon his ability and judgment in directing the officers under him and in correlating the work of all departments.

After the perfection of the operating organization, the principal duty of the president is the formulation of the general policies which will lead to profitable operation. In any business it is the judicious expenditure of money which makes possible an increase of earnings and of profits. It is the president's office to decide when and how additional funds may be invested in new equipment, in grade reductions, in improved facilities or in line extensions, so that the net revenues of the railroad may be increased. The superintendent of motive power wants new and improved power and enlarged shop facilities, the chief engineer likes to lay new rail and apply ballast and renew ties, but the president must be the judge of whether or not such expenditures are justified by their possible effect upon the operating ratio.

New equipment, and track and structures are only rarely financed out of the earnings of the railroad. When such improvements are made it is usually necessary for the railroad to borrow money to cover the investment, and when money is borrowed interest must be paid. The president must know, when he asks his board of directors and the Interstate Commerce

Commission to authorize a new bond issue, that the money raised and invested will earn an adequate return in increased business or decreased operating expense.

The president of a railroad has a triple responsibility. He is responsible to the traveling and shipping public for adequate and satisfactory service, to the stockholders for economy in operation and to the organization for just and competent administration. The president must know many things about finance, and organization and operation, and he must know them well. Experience in the lower offices of the railroad will teach him some of the things which he must know, but only intensive and continuous study will perfect him in all of the duties which he must perform.

134. The Vice Presidents.

Railroad vice presidents are usually specialists in some particular branch of the business and their duties depend upon the department to which they are assigned. The operating vice president is the most important officer, next to the president, and he is usually the man who steps into the presidency when there is a vacancy. Other vice presidents may be assigned to the supervision of traffic, or accounting, or construction, or purchasing or any of the other divisions of railroad activity and for the proper functioning of these departments they are responsible to the president.

Practically all of the railroad vice presidents at the present moment are men who have come up from the ranks of the various departments, men who have made themselves specialists in their lines and who by their intimate knowledge of all of the details of their departments, have become valuable members of the general staff.

135. The Operating Vice President.

The operating vice president is the actual head of the operating organization and upon his shoulders falls the responsibility for efficient operation. There are many thousands of items which go to make up the total cost of running a railroad and lack

of efficiency in one department may offset the best efforts of all of the others. It is the vice president's duty to see that operating expenses are held well within operating revenues so that there may be a margin for the payment of taxes, interest and dividends.

The operating ratio, that is the relation expressed in percentage between revenues and expenses, is the gauge which measures the efficiency of operation. If ninety cents out of every dollar received from shippers and passengers is expended in running trains and in maintaining the power and rolling stock the operating ratio is 90 per cent and only 10 per cent of the total revenue is available for the payment of taxes, interest on bonds, dividends on stock and for investment in the improvement of facilities.

When revenues decrease with the falling off of business, as they do at frequent intervals, it is the business of the operating vice president to reduce expenses so as to maintain the operating ratio if possible. The man in the ranks frequently does not understand why shops are closed down and forces laid off and is resentful that a great rich corporation should take away his earning power. It is unfortunate for the individual that such measures are necessary, but they are if the financial integrity of the company is to be preserved, and unless the railroad is fairly prosperous both employees and patrons and owners will suffer.

One of the greatest problems of the operating officer is to hold expenses within reasonable limits without constantly increasing and decreasing working forces with all of the inefficiency incident to such procedure. It requires years to train a man into a competent mechanic or train man or engine man or track man, and when men so trained must be laid off the loss falls upon the railroad as well as upon the individual. At the present moment the operating officers of the more progressive railroads are devoting much attention to the working out of a plan whereby the work in the various departments may be equalized throughout the year and over a period of years so that it will be possible to operate through seasons of good business or bad without

decreasing or increasing forces. A great deal may be done along this line by careful planning of the work so that expenses are held down during periods of good business, so as to create a surplus for use when depressions come.

The railroads are paying far more attention to the problems of personal relations within the organization than they ever did in the past. This is as it should be. The efficiency of operation depends largely upon the maintenance of a steady and competent working force in all departments and every improvement in working conditions contributes to the desirable end of attracting and holding high-class men. The vice president in charge of operation is the officer who is responsible for the policies which direct the handling of the working force all down the line in all departments of the operating organization.

Whether the form of organization be departmental or divisional it is the operating vice president who must harmonize the work of all of the lesser officials so that each department or division will contribute its full share toward efficiency of operation. The mechanical man sees one side of the transportation problem, the transportation man another and the track man still another. The traffic man has an entirely different point of view from that of any of the operating officers, as have the officers in charge of purchases or of accounting. It is the operating vice president's business to hold the balance between all of the departments and to co-ordinate their work to the best interests of the railroad as a whole.

It is evident, then, that the operating vice president must be a thorough, all-around railroad man who understands the importance of each department and its relation to the general scheme of transportation. Chief operating officers have come up from all of the operating departments, mechanical, maintenance of way and transportation, and a man in any branch of the service may well aspire to the position. But no man can hope to rise to the higher positions in the management unless he has made a study of the problems of all of the operating departments.

136. The Superintendent of Motive Power.

Back in the early days of the railroads the superintendent of motive power was merely an exceptionally good mechanic with some ability to handle men. At the present time this official must be far more than that. He must have exceptional business ability and be possessed of financial sense. The mechanical department of a large railroad spends annually millions of dollars for materials and labor and the superintendent of motive power is responsible for these expenditures. He has on his hands the administration of a business only equaled in size by a few of the larger industrial corporations.

The superintendent of motive power has the principal voice in deciding what designs of locomotives and cars shall be purchased, and what improvements shall be made in existing types. It is his duty to outline shop practices and to plan improvements in facilities for repairing locomotives and cars. In addition he must supervise the work of all of the shops, roundhouses and car repair plants and must handle the organization with which they are operated.

The mechanical department has no direct source of revenue but must depend upon appropriations from the income of the railroad to finance its activities. The superintendent of motive power is expected to hold his expenditures within certain fixed limits, but at the same time he is required to furnish to the transportation department an adequate supply of power and rolling stock in good condition. This means that he must be constantly on the alert to detect and eliminate wasteful practices in his department, so that the maximum of results may be obtained with the minimum expenditure.

137. The Chief Engineer.

The chief engineer stands in the same relation to the maintenance of way department as the superintendent does to the mechanical department. He must spend nearly if not quite as much money in keeping up the track, grade and buildings as does the superintendent of motive power in maintaining the

equipment, and he is governed by the same necessity of seeing that every dollar is well spent.

The mechanical and track departments must work closely together in the development of improved operating conditions. When the motive department contemplates the purchase of heavier power, the track department must make plans for the strengthening of roadway and bridges. The reduction of grades and the elimination of curvature increases the potential capacity of the motive power.

138. The General Manager.

In this chapter it is assumed that the general manager is a transportation department official and that the other departments are handled more or less independently by separate chief officers. This is not always the case, as the general manager frequently has more or less authority over the mechanical and maintenance of way departments. When this is the case the duties of the mechanical and track department heads are not materially altered, although they may report partly or entirely to the general manager instead of to the operating vice president.

The general manager is chiefly responsible for the operation of trains and for all of the co-ordinate activities which contribute to the transportation of freight and passengers. When the mechanical department has contributed locomotives and cars in serviceable condition and when the maintenance of way department has supplied track and yard facilities, it is the business of the general manager to see that the equipment on road way is used in the most efficient possible manner. James J. Hill, than whom no greater railroad operating man ever lived, originated the axiom that "expenses are by the train mile, revenues by the ton mile." The principle is the same as that of quantity production, which has brought many of the luxuries of life within the reach of the man of moderate income.

The transportation department takes the tools furnished by the other departments, in the way of equipment and facilities, and with them manufactures ton miles and passenger car miles. Good tools do not in themselves mean efficient production. The

good mechanic will turn out more and better work with an old lathe and an ordinary carbon tool than will the dub with the most up-to-date machine and the best high-speed cutters.

The general manager's duties are complex and difficult. He has less to do with technical problems than has the superintendent of motive power or the chief engineer and his success depends largely upon his ability to handle men and to persuade them to make the best use of the facilities and equipment which are placed in their charge.

CHAPTER XXII

SHOP SUPERVISION

139. Training Shop Supervisory Forces.

The subject of shop supervision cannot be better introduced than by quoting at length an address of Mr. L. W. Baldwin, president of the Missouri Pacific, delivered before a meeting of Division V—Mechanical of the American Railway Association. Mr. Baldwin's right to be heard and listened to with respectful attention on any phase of railroad operation is well established. What he has done with the rundown property of the Missouri Pacific in the space of a few short years is a matter of common knowledge, and any man who could make a railroad out of the Missouri Pacific, as we knew it ten years ago, must be a railroad man of very superior ability. He said:

"No railroad ever can be better than its motive power. Without adequate and dependable power there can be no hope of successful railroading. And the condition of our locomotives is largely dependent on the supervisory forces in our shops and roundhouses. There is no more important duty than that of training our supervision.

"An operating division of a railroad is no better than the superintendent of that division; likewise a locomotive shop is no better than the man in charge, be he called master mechanic or superintendent. We may send all of our experts to a division to help a man operate it or show him how to operate it, or we may send them all to a shop to show the man in charge how to handle it, but in neither case can we get results unless we have, as the man in charge, one who is in sympathy with progress and one who is willing to keep an open mind and is possessed of a mind able to absorb and get from such experts their good practical suggestions and instructions.

140. Apprenticeship the Foundation.

"It is an accepted fact that the problem begins with the selection of the apprentice. An apprentice should have at least a fair elementary education and something of his habits, inclinations, personality, home life and surroundings should be known to the employing officer, as every care should be exercised in selecting apprentices. Throughout his apprenticeship, the future mechanic and possible future supervisory officer should have the personal supervision and sympathetic leadership of his foreman.

"Some 'yardstick' or system of measurement should be devised so that each apprentice may be properly advised and made to know the quantity and quality of work done by him as compared with the work done by other apprentices in the same craft in the same shop; and I even believe it would be better if he was shown similar information regarding the work of other apprentices doing similar work in other shops. Further a systematic record of his progressive steps should be carefully kept and he should be required to pass stipulated examinations at stated intervals in his apprenticeship to insure his being a satisfactory and valuable mechanic when he is promoted to that position.

"In addition to shop work, some kind of school system should be devised in larger shops under which the apprentice may have an opportunity to get technical knowledge at the same time he is attaining practical experience and instruction. It is during this period in the career of the apprentice that he should first be taught right thinking, the necessity of loyalty, good citizenship, and the will to do.

141. Inspiring the Mechanic.

"When the boy has served his apprenticeship and become a mechanic, it becomes the duty of the gang foreman, the foreman and the other supervisory officers to aid him in developing new ideas in his work, a sense of devotion to duty, and to continue to interest him in being able to do a little better than the

other men—possibly a little more than the other men. Again develop ‘yardsticks’ by which the work of the mechanics may be measured in order that the man may know the results of his labors as compared with the work of all other men working in similar positions, for when one works and does not know himself and knows his superior does not know what is accomplished, what possible incentive is there for him to do more?

“It is, therefore, incumbent upon the supervision to devise the proper yardstick for the measurement of the work done and for the purpose of acquainting all with what is accomplished. Otherwise you might liken a man’s work to a man moving a pile of sand from one location to another while one man is filling the vacancy made by him on one side and still another is taking away the second pile as fast as he builds it. He sees no results of his efforts and unless you can find some way to advise a man working in this way of the results of his efforts there can be no incentive or continued desire to do.

“Throughout all of this, men should be treated fairly and justly by the supervision, for nothing is more difficult to overcome than prejudice and resentment brought about by injustice and lack of appreciation.

“Every man in the mechanical department should be informed of the importance of his work and its relation and relative importance to the whole, as compared with other work making up the whole. Every individual should be made to understand that a chain is no stronger than its weakest link and unless his particular work is done well the effort of his fellow employees, along with his own work, is wasted. If by chance a failure or accident occur because of the failure of some one employee to do his work properly and well, it should be shown to him so that he will understand it. He should be told not only that his work was wrong but he should be given a detailed explanation, showing the result of the wrong work.

“If we expect the best that is in men, we must let them know what is required of them and why. I would like to illustrate what I mean by referring to a personal experience.

At one time an emergency made it necessary to do a certain piece of work in a given time. The task looked almost impossible to some of my associates, but I said it would be done. Then I went to the men and told them all about it. I told them that it had to be done and why and I told them that I was depending on each and every man to do his part. The work was finished ahead of schedule.

142. Habits of Steadiness and Reliability.

"Another important thing is the necessity for teaching the man the value of sticking to the job. The man who becomes a 'boomer' does not usually progress far. I do not mean that the employee should specialize in one particular operation. He should not. The man who does that automatically limits the extent to which he can advance. Employees should be encouraged to master as many different operations as possible because it is the man with the good general practical knowledge of more than one operation—the more the better—who is best fitted for a supervisory position. But the man who becomes a 'boomer' does not as a rule provide good material for promotion. It is the man who establishes a reputation for steadiness and reliability who usually gets the most consideration when a promotion is to be made. Employees should be taught to realize this.

"Employees should be encouraged to develop their initiative from the day of their employment. They should be encouraged to study their work intensively and they should be encouraged to learn all they can about the work of the man next to them. Employees who make mistakes trying to do something should be encouraged rather than censured. A careless or reckless waste of time or material in attempting foolish or impractical things is not to be condoned under any circumstances, but the employee who is willing to try to do something a little better than it has been done before needs and should have the encouragement and assistance of his superiors.

"Employees should, of course, be taught the importance and the value of being loyal to the company as well as being good, loyal, dependable, patriotic citizens. Loyalty to the company

and pride in their work are two of the most important things men can develop.

143. Selecting Men for Promotion.

“Whenever there is a vacancy for a gang foreman or other foreman, there should be many competent and available men for the position. Every characteristic and quality of each available man should be taken into consideration by the supervisory officers in order that the man best fitted, and the man who can maintain the respect of the men who will come under him, is selected to fill the vacancy. This should be followed at each succeeding step in the selection of higher supervisory forces. And each time a vacancy is filled utmost care should be exercised to the end that no injustice is done in selecting the man for the position—either to the individual or to the property.

“Foremen and their superiors should themselves learn to study the various reports that are made, with a view to understanding both the reason for them and the information contained in them and how best to use that information in obtaining better results. Men should be taught that reports are not prepared primarily for the general officers of the railroad but that, except in rare instances, they are designed with a view to providing the immediate supervisory officers with a record of work being done. They should, with regularity, use such reports to provide a proper incentive, for themselves, comparing their work and their results with others and using it to inspire their associates and subordinates. I believe this is a place where some of your hardest work and greatest energy can be best applied.

“There is hardly any work done by locomotives and cars that cannot be worked out on a basis of cost by using the man hour unit of measure, and I have, personally, from time to time, gotten great good out of studying the cost of each class of work on locomotives and cars by measuring the results in man hours, not only for labor but for material as well. If such a yardstick is used it is most helpful for each gang of men, at least, if not each individual man, to know what their

work or his work is costing in comparison with that done by other gangs or other men.

"I have found by using the man-hour basis over a period of time that we can get yardsticks without any accounting or increased clerical force and the cost can be so worked out as to provide, economically, an incentive for efficiency and economy. Every man feels better when he knows that his work has been done well and further that the man to whom he reports knows that it has been done well. Foremen should be taught to analyze and use reports of this kind, so they can in turn promulgate the information among their subordinates and associates and use it if and when they may be promoted to positions of greater authority and responsibility.

144. Maintaining the Interest of the Men.

"All of this, of course, requires constant, close association of the supervisory forces and a personal interest that must be genuine. One of the biggest and most important tasks of the foreman, is to manifest the necessary personal interest in every apprentice and every mechanic under his supervision and inspire in them an ambition to learn all about their work and accomplish it a little better and a little more efficiently. As the superior officer is promoted from position to position, it becomes increasingly difficult to maintain that personal contact and personal interest, but it is none the less important and necessary that he do so and so handle his affairs that it will be possible for him to do so.

"One of the results from this association of supervisory force and men should be the encouragement of every employee of every degree to develop new ideas—new methods of doing work. Supervisory officers should encourage employees to make suggestions regarding everything and anything connected with their work. Foremen and supervisory officers should receive and treat all such suggestions with utmost seriousness. If the idea submitted is a practical one the man responsible should receive full credit and encouragement. I venture to say that there is no shop in the country so operated that any of you, conversant

with the particular class of operations, cannot go to it and make an improvement in the production by studying the methods. You can do that if you go there with an open mind for that purpose and stay there long enough to study the entire operation. Therefore, it is reasonable to expect good suggestions from all of the men and from every man in connection with his particular work. By so doing it will be possible to lower your costs, and, at the same time, increase your output.

"There must be a point of contact between the employees and the management to insure justice being done employees. Foremen and supervisory officers who are properly trained should welcome, with the employees, such contact because, in the last analysis, no right-thinking foreman or supervisory officer wants an injustice done to another man. Therefore, I believe it is wise to set up and to encourage the setting up of such contacts as will insure full justice being done to all people who are working in the shops.

"Just as apprentices and machinists should study their work and duties so as to be able to put the most into them and get the most out of them, so the foremen and other supervisory officers should study their duties. They should study the achievements of the men under them and they should study the methods and practices in use. There is room for great improvement in the efficient and economical operation of our shops if the supervisory officers will get into this question.

"Gang foremen, foremen and general foremen should apply the same comparative study of their gangs, and the men under them, that the mechanic applies to himself. They should know what results other foremen and other gangs doing the same kind of work are getting and they should apply the yardstick to their own efforts.

"And just as when there is a vacancy in the ranks of the gang foremen to be filled so there should be many men available when there is need for a man as general foreman, master mechanic, superintendent of motive power or any other supervisory position. And as in the first case, every consideration should be given to all of the available men whenever a promo-

tion is to be made. The qualifications of each man should be most carefully studied and his fitness for the particular duty should be thoroughly gone into.

“What can be more important to a railroad than to have a roundhouse foreman who can and will have the locomotives ready for service when they should be ready? And likewise, there is nothing more disastrous than for the roundhouse foreman to fail to have power ready when it is needed and should be available. He also must be a man who can and will study his work, his duties and his responsibilities, and keep account of his costs and expenses and work out ways and means to handle his power more economically as well as more efficiently.

145. The General Officers.

“The work of the general supervisory officers can be made more efficient in exactly the same way. They should have yardsticks by which they can measure the achievements of one shop or roundhouse against another. And they should see that all the men reporting under them have an opportunity to study these comparisons. General supervisory officers should analyze the whole shops and roundhouses and the relations of one to another and of each to the whole railroad. This naturally cannot be done in hurried inspection trips that are made at more or less frequent intervals. General supervisory officers must get down on the ground and study out these and their other problems by close application and personal contact just as the lesser supervisory officers and the individuals must study out in detail, their problem.

146. New Tools and Appliances.

“General supervisory officers can and should devote careful study to the use of machine tools. They should study the output of all such tools, analyzing them. They should know when such a tool should be replaced or when a new one could be installed with advantage. They should constantly keep posted on the latest developments along this line and when it is decided to install a new tool, they should know the best one to

buy and where to get it at the best price. They should know also, that the installation of a new tool will result in greater efficiency and greater economy, for the installation of new and improved machinery can be carried to excess and to a point where it is wasteful. Every precaution should be taken to know definitely the kind of tool needed and what results can reasonably be expected when it is put in operation. I believe a committee of general supervisory officers could well afford to devote a definite part of their time, in addition to their other duties, to intensive study along these lines.

"All supervisory officers should keep constantly posted on new appliances for locomotives and cars which will result in more economical operation and maintenance. In order to do this it will be necessary to study each new device and every innovation. This is most important and proper handling gets great results both in service and economy. General supervisory officers also should keep abreast of the times in all matters such as improved design and construction of locomotives and cars. They should know the latest and most approved and best methods of rebuilding engines and cars.

"I always have been sympathetic with and believe in such conventions as this, because men who are in charge of shops have an opportunity to meet with each other and study these wonderful exhibits both of designs and methods for the better handling of their work. * * *

"In conclusion, with reference to the proper training of shop supervisory forces, we must remember that throughout it all there must be a feeling of real fellowship, real sympathy and understanding for the problems of the other fellow. After all service is the keynote of the whole thing: service to the company, that the company may give service to the public; and service to each other that all may prosper and progress together."

147. The President's Viewpoint.

The opinions which have just been quoted are those of a highly successful railroad president and are worthy of careful

study by the aspiring man in the ranks as representing the viewpoint of the man who has risen to the highest position in the organization. Success is not a matter which can be expressed by blueprints and specifications; there is no set of rules the literal following of which assures rapid promotion; every man must find the way to the top for himself, but the advice of those who have gone before is of the greatest assistance.

It may be well to point out and emphasize some of the features of successful foremanship which Mr. Baldwin mentions, so that the student's conception of the chapter may be clear and definite. The outstanding points are:

Inspiration.

Selection.

Interest.

Study.

Measurement.

We hear a great deal of the inspiration of the artist or the author, and very little of the inspiration which leads ordinary men to accomplish unusual results. But, inspiration is as necessary to the mechanic who aspires to foremanship as it is to the painter who hopes to create a great picture. Inspiration is nothing more nor less than a strong desire to accomplish a certain result; without such desire no man succeeds, with it all obstacles are overcome.

The selection of the proper man for the place is one of the prime essentials of efficient organization. The selection of the proper line, by the individual, is perhaps the most important factor of his success. The misplaced man is without inspiration or interest and his hope for advancement is very slight. The individual should select for himself the line of advancement he wishes to follow; the man who has risen to a position of authority should select his subordinates with care, not only for their mechanical ability, and for their efficiency, but for their interest in the tasks to which they are to be assigned.

Interest may be partly a matter of inspiration, partly of selection, but it is more than either. Inspiration may be temporary and interest is required for sustained effort. A man

may be well placed but lack ambition to rise, and when strong interest in future progress is not present there will be no advancement.

The importance of constant and intelligent study cannot be over-emphasized. The mechanical executive must have a very wide range of exact knowledge of many subjects and he cannot depend upon everyday experience in the shop to provide the education which he must have to rise to the higher places in the management. The mechanic or the foreman in the shop easily learns the details of the mechanical processes which go on about him daily, but such knowledge merely makes him a good workman and does not fit him for anything better. It is the knowledge of things which are being done in other shops, the understanding of the duties of officers higher in the organization, the study of the principles of industrial management, that fit the man for indefinite promotion.

Could a mechanic work without his scale, his calipers, and his micrometers? Certainly not. Neither can the executive accomplish results without standards by which to measure the work which is done under his supervision. Many chapters in this course are given to standards of measurement of cost and performance because the subject is of the utmost importance to the man in the supervisory capacity. No man can judge of the results which he is accomplishing unless he has some means of measuring them against the work of other men or against his own past performance, and it is only by the comparison of results that consistent improvement may be expected.

CHAPTER XXIII

THE RAILROAD LABOR PROBLEM

148. A Digest of Opinion.

The subject of railroad labor, perhaps the most important and difficult problem of management, can best be introduced by quoting the report of the Committee on Economics of Railway Labor, of the American Railway Engineering Association:

"The committee concentrated its attention, in the study of this subject, to the investigation of the plans developed by other large employers of labor to promote continuity of service and efficiency in production. Individual members of the committee have investigated those organizations whose results have been noteworthy, giving preference as far as possible to those companies whose operations have extended over a wide area and to those methods which are applicable to the conditions found in railway service.

"In its investigations, the committee found that the outstanding feature of all data collected is the emphasis placed upon co-operation in industry and that the recognition of the distinctive rights, responsibilities and obligations of employers and employees has been the foundation on which the plans in all industries rest. A harmonious understanding of the proper relationship between officers, foremen and workmen of an organization is a basic requirement.

"It is in the establishment of proper methods to accomplish such a purpose that enlightenment from the experience of those other industries most closely related to the railroad industry is of service. The methods that have been investigated by the committee may be grouped under the following descriptive headings:

- "1. Personnel Departments:
 - (a) Employment, promotion and transfer.
 - (b) Education, training and service.
 - (1) Foremen's training courses.
 - (2) Apprentice systems.
- "2. Employee Representation in Management.
- "3. Benefit Associations:
 - (a) Insurance, providing for
 - Sickness.
 - Accident.
 - Unemployment.
 - Superannuation.
 - Death.
 - (b) Saving funds.
 - (c) Loan provisions.
- "4. Stock Ownership.
- "5. Welfare:
 - (a) Working conditions.
 - (b) Safety, health, etc.
 - (c) Rest-houses, rest-rooms, meals, etc.
 - (d) Recreation.
 - (e) Homes.
- "6. Incentive Plans:
 - (a) Standards and units of measure.
 - (b) Bonus payment.

149. Personnel Department.

"Those railroads and other companies which have personnel departments demonstrate the benefits derived from the unbiased and helpful treatment of their employees from the date of their entrance into service through all the period of their employment. These departments commonly handle all applications for employment and are responsible for the employee meeting the company's requirements as to ability, physical condition and mental qualifications. Records of service of employees and continual contact with the men are maintained to see that their service is mutually satisfactory, transfers made when occasion

requires and equal opportunity for promotion given. Education of employees in the technique of their occupation is provided when the interest of a sufficient number is enlisted.

"Foremen's training courses, originating upon the request of a sufficient number of employees but assisted by a 50-50 contribution upon the part of the management, have been operating in many establishments with mutually beneficial results. Recognition of meritorious service and report of disciplinary action is frequently given to this department and is closely followed by it in the records of service to see that absolute fairness is accorded.

150. Employee Representation in Management.

"Plans for employee representation in management were found to be quite generally in use by the companies investigated. The guiding principle in their establishment was the avowed intent of the managers to insure a 'square deal' and a real spirit of co-operation.

"The plans are organized along similar lines, though differing in detail. Usually there are established 'shop councils' or 'conference committees' with equal representation by employee and management representatives independently chosen. Periodical meetings of these councils are held at which matters of mutual interest are discussed.

"Wage negotiations, working conditions, hours of labor, disputes, suggestions for improvements, grievances, etc., are taken up at these conferences and agreements reached where possible. In case of disagreement there is the right of appeal to similarly constituted committees as represented by a general council which consists of employee and management representatives for the entire plant or the industry. Provision is made to carry appeals finally to boards of directors and even beyond to two outside arbitrators chosen respectively by each party, a third being chosen by the two appointed.

(Note—The similarity between the plan here described and that which is being tried out on the Pennsylvania Railroad, as outlined in another chapter, should be noted.)

"Testimony has been given to the comparatively few disputes which have been carried beyond the works' council, even in industries where employee representation plans have been in existence for five years or more.

"All of these companies stress the point that the plans are designed to give the employees a voice in the management, particularly where their own interests are at stake. The real objective is harmony and co-operation. Open dealing and sincerity with no ulterior motive or suggestion of purpose other than that of mutual helpfulness are basic fundamentals of these plans.

"That they have been so founded and that the results have been of immeasurable benefit to those industries now continuing the plans is evidenced by the testimony of the responsible officers of the organizations and by the very fact of their continued existence. While the participation of the employees is quite common in the management of many industries, this plan has been tried only to a limited extent in railway service.

151. Benefit Associations.

"Among the plans affecting the welfare of employees which have been adopted most freely by the railroads and other industries alike are the establishment of insurance funds giving protection against the five main hazards of life, viz., sickness, accident, unemployment, superannuation and death. For many years relief associations have existed on a number of railroads as well as in other industries which have incorporated plans for insurance covering all of these hazards except unemployment. Nearly fifty of the largest railroads in the country have in effect pension systems for employees retired or incapacitated for service. Some of these roads also include provisions for savings funds and loans. More recently, at least one railroad has included unemployment insurance in its plan. The outside industries investigated were generally found to have in effect insurance plans which covered variously some of the benefits above listed.

"In the operation of a relief department, which embodies all of the above features excepting the provision for unemploy-

ment, on one of the leading railroads for a period of more than forty years, there is evidence of its value not alone to employees but to the company itself. The sick benefits, the pensions, the opportunities provided for saving in a guaranteed fund, and the advantages accruing from the privilege of borrowing from that fund in order to build a home, make an appeal to loyalty that could only be secured through such tangible evidence of the good faith and good will of the company itself.

"A few large railroad systems are now carrying group insurance in which fifty or more employees are insured under a policy issued to the employer by an outside insurance company, the premium being paid wholly by the employer or jointly by the employee and the employer. There is in the group insurance policy the evidence of the desire to emphasize the importance of human interest in the relationship of employer and employee.

"It is an advance step in affording economic security for the employee and his family. When that is established and when fear of the hazards of life are removed through insurance provisions for dependents, there is beginning the elimination of much of that discontent that now results in the uneconomic movement of workers.

152. Stock Ownership.

"Plans for the participation of employees in the ownership of the industry from which they gain their livelihood, through the purchase of its stock, have received a great deal of attention from some of the largest and most successful industrial corporations. These plans have also been followed for a number of years by some of the railways and have been adopted by others within recent months. One corporation in this country, having probably the largest number of employees, has had such a plan in effect for twenty years. Another company has had such a plan in effect for a number of years. The success of those two companies alone makes it incumbent upon railways whose work is similarly diversified and whose employees rank in numbers, to study their results.

"It must be recognized that employees in most groups other than the supervisory one depend upon group action for an increase in their wages. It would be socially undesirable to exert such an economic force as to restrict their freedom of action.

153. Welfare.

"Welfare work is widely and variously practised in most American industries. It ranges from simple provisions for healthful and safe conditions in the plants, to the establishment of departments that foster interest in athletics, recreation and entertainments of every character. In some cases it has extended to the appointment of investigators who visit the homes and families of the employees periodically for the purpose of insuring healthful and comfortable conditions in the home life of all employees. In the case of at least one of the largest of our manufacturing companies, such an investigation is extended to the personal habits and thrift of their employees, though it is understood that the later practices of that department do not generally cover such investigation, being limited to such inquiry into the home life as would develop the need for assistance in case of sickness or other misfortune which the company, according to its determination, elects to relieve.

154. Incentive Plans.

"Incentive plans have been extensively adopted by industries covered by the committee's examinations. The objectives were numerous, but in their aggregate were designed to avoid the waste due to absences, lateness and loafing, to develop interest and skill in the work, to increase production and to inspire loyalty and co-operation.

"The investigation by the committee of companies which have adopted and are using standard production methods consisted largely of a review of various plans of piece work, bonus and similar individual incentive plans in which the wage payment to the employee was based upon his individual performance. It is generally conceded that where there is any

basis for measuring and rewarding individual effort, there is foundation for just and adequate compensation. Usually, it is only when such individual incentive plans based upon production records are not possible of application, that companies have resorted to other incentive plans and profit sharing, bonus payments for avoidance of tardiness and absence, and prevention of waste, stock sales, etc., are made effective.

"The principle of piece-work payment is fundamentally sound. Where the work done by an individual is susceptible of definite measurement the most effective method of promoting efficiency is to establish a method of payment resting upon the work performed. Such plans are in successful operation in industries such as cigar-making, garment-making, coal mining and manufacturing plants where machine output can be definitely measured.

"It has not been found that the number of companies which have discontinued piece-work plans constitute a very large percentage of the whole number that had adopted such plans, and it may be fairly concluded that there is not sufficient merit in such objections account of exhaustion of workers, impairment of quality and destruction of the co-operative spirit as were advanced by these companies, to warrant condemnation of these piece-work and direct-bonus payment plans as a whole.

"Those plans had been rather extensively employed in railroad shops and, in a few instances, in maintenance of way work, for a number of years prior to federal control, and are now in a fair way to re-establishment in some of the shops where they were formerly in effect. In shops the piece-work plan is more directly applicable; in maintenance of way work, a modified piece-work or a bonus plan is better suited by reason of the fact that production is easily measured for a gang rather than for an individual.

"The use of such plans in maintenance of way work does not necessarily involve the payment of additional compensation, though it is evident that the ideal results would be attained only when such end was successfully and practically accomplished. It has been found that the very establishment of a

standard performance has had beneficial effect and that gangs that are subject to time study or have been made acquainted with results of such studies have been inspired to match the standard and the results accomplished by other gangs.

"The term 'bonus' has been applied so indiscriminately to piece-work and other methods of payment of added compensation to employees that it is necessary to limit the meaning of the term in order to make it distinctive from other incentive plans. As here considered, it relates to extra compensation paid in order to secure length of service, avoidance of lateness and absence, prevention of waste and similar features of employment to which the employee may not feel obligated to give particular attention, but which results in loss to the company unless the practices are corrected. Bonus payments to reduce lateness, absences, and wastage are effective, but when added to the pay envelope they may become sources of friction which result in defeating the ends they have planned to serve.

155. Conclusions.

"1.—In order to retain satisfactory employees, railway managements should provide means for the fullest possible co-operation between employer and employee, arranging for the education of all employees and particularly for those in a supervisory capacity in the aims of the company to secure that result.

"2.—Where roads are of sufficient size to warrant the creation of a personnel department, it is recommended that such a department be established whose duties shall be the encouragement of employees and their handling without prejudice, in their employment, promotion and transfer and in their education, training and service, including foremen's training courses and apprentice systems; discipline and separations from service. On smaller roads work of the character above outlined should be assigned to some officer in the existing organization, to be handled independently of his relation to any particular department.

"3.—The adoption of a plan of employee representation in railroad work, will, through the improvement of the spirit of

co-operation, serve largely to stabilize labor and reduce the problem of obtaining new employees.

"4.—The extension of benefit associations providing insurance against the hazards of sickness, accident, superannuation and death is essential to the development of a loyal and co-operative spirit in railway organizations, which is needed to assist in the stabilization of labor and in rendering it more efficient and economical. Savings funds and loan provisions placed at the disposal of all worthy employees are an added incentive of merit and of economic value.

"5.—The promotion of the mutual interests of employers and employees through participation in the ownership of the industry on which they are dependent for their income in wages or dividends is an objective greatly to be desired and warrants the careful consideration of the railroads as a means of stimulating co-operation in the common objective.

"6.—Plans for the establishment of satisfactory working conditions, including the provision of sanitary and agreeable facilities while on duty, comfortable rest houses, rest rooms and dining rooms, maintained in cleanly condition, and service of a sufficient quantity of wholesome food, should be in effect on all roads.

"7.—The establishment of standards and units of measure for all work performed which is susceptible of measurement, is a fundamental basis of harmonious understanding between employer and employee and the foundation for the economical and efficient handling of labor.

"8.—The committee suggest for further examination and such use by individual companies as their judgment may determine the following plans which have come under the investigation of this committee:

"A.—Guaranteed employment or unemployment insurance—these are prompted by the desire to provide continued employment, free the employee of anxiety and insure co-operation.

"B.—Bonus payments for continued service, avoidance of lateness and absence, prevention of waste and other features of

economic operation concerning which the employee may not have full realization of his obligation."

It should be understood that the report of the committee just quoted is given space because it indicates the extent to which investigation is proceeding, and outlines in some detail many of the important features of the problem of force management. The student should not get the impression that all of the recommendations of this committee are indorsed, for that would be far from the truth. Many of the plans advanced are more or less visionary, and some are parental in nature. The American workman is too independent and self-sufficient to take fully to many of these plans for taking over the supervision of the intimate details of his daily life, and the successful scheme of co-operation must be one which recognizes the quality of all men regardless of their present position in the industrial scale.

In quoting extensively from the report of this committee the whole idea is to give the student an insight into the processes which are being gone through by different bodies of men in an endeavor to improve our industrial conditions, and it remains for the reader to draw his own conclusions from the evidence presented. In other chapters the opinions of practical railroad men and executives of all ranks are presented and certain conclusions are deduced.

Particular attention should be called to the fact that the committee just quoted rather leans toward the establishment of some form of unemployment insurance. The attention of the student is invited to the fact that England has gone rather extensively into this matter, and that the failure of that country to recover from the effects of the late war as it should, is attributed by economists to the demoralizing effect of this same unemployment dole. The American workman would never stand for this system of subsidizing idleness.

CHAPTER XXIV

PERSONAL RELATIONS

156. The Machine and the Man.

The development of vastly improved machinery and facilities for performing industrial operations, which has taken place during the past few decades, has increased rather than decreased the importance of the man element. While the actual cost of the labor required to complete a certain task is decreased by the introduction of an improved machine, the importance of the efficiency of such labor is frequently greatly increased. In the manufacturing processes, the greatest single item of expense is nearly always, not the direct labor, nor the direct material, but the overhead. The interest on the investment in plant and equipment, the depreciation and repairs on buildings and machinery, the cost of general supervision and of miscellaneous labor, runs into larger and larger sums as the equipment becomes more complicated and costly.

While the accounting practice of the railroads is not to charge against the actual cost of the operation of shops all of the items of overhead, but only those which accrue directly in the shop, the condition is the same as in the factory. Every increase in the investment in equipment and facilities, designed to expedite the work and decrease the direct labor costs, adds greatly to the overhead, and as this charge must be assessed against the work, either on the basis of man hours, direct payroll dollars, or machine hours, the effect of the personal efficiency of the workman is increased rather than decreased with every improvement in facilities.

Proper organization and adequate system are, to be sure, important essentials of force efficiency, but their effectiveness in producing results is dependent upon the character of the

personal relations which exist between the management and the working force. When management is spoken of the entire organization for supervision is included, from the gang foreman who handles a dozen men to the president of the road. The foreman is the direct representative of the management in the shop, and his relations with his men will have a close and important bearing upon the force efficiency.

As a general proposition it may be said that the best foreman is the man who is able to secure the most complete co-operation from the forces under his supervision, rather than the man who has the most perfect understanding of machines and methods. Thorough knowledge of the processes which are applied in his department is by no means unimportant, but such knowledge alone, while it may fit a man for specialization along certain lines, does not make him a good executive.

The most active foreman can only supervise a very small proportion of the operations which go on under his direction and he must depend largely upon the ability and the willingness of his workmen to carry out the tasks which are assigned to them in the proper manner and in reasonable time. The foreman's personal relations with his men will always be the controlling factor in securing both quantity and quality of work.

157. The Hire and Fire System.

The old system of force management, to which some executives still adhere, was to fire any man who for any reason did not come up to the requirements of the position in which he was placed, or who did not exactly suit the foreman's taste, and to hire another man to take his place. The labor turnover under such a system is enormous and the force efficiency is always low, not only because of the loss occasioned by constantly breaking in new men, but because of the psychological effect which such a system must have upon workers in general.

The first essential to force efficiency is a feeling of certainty on the part of every man that so long as he makes a proper effort and departs himself reasonably well his job is secure. There are a few born "boomers," but most men have the desire

to establish themselves in one place where there is an assurance of fair treatment and a prospect for progress. The old traveling journeyman looked down upon the "home guard" shop with the greatest contempt, principally because there was little chance for him to find temporary employment there, but these shops were always the most efficient because they maintained the same force of men from year to year, men who were building homes and raising families, and whose interest was centered in the community as well as in the shop.

Another important factor of shop efficiency is the proper placing of men, so that they are not only fully competent to perform the tasks to which they are assigned, but further that they take a proper interest in their work. Men become dissatisfied, not because they are asked to work hard and continuously, but rather when the job assigned to them is, for some reason, distasteful. In placing men their fitness should, of course, be given first consideration, but their inclinations should not be overlooked.

158. The Modern Method.

In progressive industries everywhere, the old hire and fire method of obtaining force efficiency has been abandoned. Every important factory has a Personnel or an Employment Department, the duty of which is to look over all applicants for employment, to determine, first, their fitness for a place in the organization, and, second, to decide just where they should be placed. Such departments usually take a hand, also, in the settlement of all disputes between foremen and the men or between one workman and another. The plan is very good so far as it goes and works out excellently so long as there is not too much interference with the authority of the department heads and foremen, but even in its best form the Personnel Department does not fully solve the problem of personal relations nor insure the highest development of force efficiency. No two men can look upon a third man with the same eyes, nor will the same set of qualifications make a like appeal to any two executives. The foreman is the man who must handle the force, and his is the

responsibility for the results secured, and if he is relieved of too great a share of the authority and responsibility for the maintenance of an efficient force, by placing the full duty upon a separate department, the result may be the very opposite of that desired.

The railroads have not yet gone very extensively into the establishment of separate Employment or Personnel Departments, and it is not likely that they will do so for some time to come at least. The foreman, the shop superintendent and the master mechanic, are and will continue to be the men held responsible for the maintenance and discipline of the force, and as such is the case, the mechanical executive cannot afford to neglect this important part of his duty.

The labor unions have rightly taken steps to make it difficult to discharge a man for any slight infraction of the rules, or for a foreman to vent his personal feelings by disciplining a workman with insufficient cause. This policy works out to the advantage, not only of the individual workman, but to that of the organization as a whole. There is nothing so disastrous to discipline as undue severity, unless it be the showing of favoritism, and both of these evils are restrained by requiring the foreman to show ample cause for the discharge of a workman.

159. The Cost of Strikes.

Every executive and employee of the railroads realizes the seriousness of the suspension of work in any department on account of labor trouble. General strikes of a trade, or of a number of trades, are, fortunately, very infrequent, but the same effect as that of a general strike, but on a smaller scale, may result from minor troubles within the shop, which produce lack of harmony between the foreman and his men. The actual cost of a strike may be figured with fair accuracy, but it is not so easy to determine the cost of shop dissension which destroys shop efficiency without actually coming to the point of a complete suspension of work.

The figures given by the Attorney General of the United States which show the cost and other effects of the shopmen's

strike which started July 1st, 1922, are of interest as indicating the seriousness of such occurrences. A part of the report made by the Attorney General to Congress is quoted below:

"The total cost of the shopmen's strike of July 1st, 1922, on the fifty railroads from which testimony was adduced amounted to \$96,501,376.00. This is only cost paid out and does not include damages to property, loss of business incurred, increased cost of doing business, nor loss by claims for damages.

"The total cost to the Department of Justice for additional United States deputies and expenses, as evidenced by certificate of August T. Seymour, acting attorney general, amounted to \$1,922,639.00.

"The fifty railroads from which proof was taken had in their employ on July 1st, 1922, prior to the strike order becoming effective, approximately 267,989 shopmen, of which number 90 to 98 per cent responded to the strike call.

"The general effect of the strike on the performance and operations of the fifty railroads from which testimony was adduced was to increase delays to freight, passenger and mail service approximately 50 per cent.

"The general effect of the strike on the motive power of the fifty railroads from which testimony was adduced was to bring about a general breakdown and deterioration of motive power, resulting in the consumption of such surplus motive power as these roads had on July 1st, 1922, and in the inability on the part of most of these roads to perform any backshop repairs during the early months of the strike and limited repairs from then on.

"The general effect of the strike on the business and industry of the country, as evidenced by the testimony of fifty-three representatives of leading business concerns of the country, was a general disturbance, slowing down of production, reduction of volume, loss of customers, and monetary losses due to delays on the part of business houses in receiving and obtaining raw materials and in shipping and transporting finished products.

"The effect of the strike on the United States Postal Department as evidenced by certificate of Harry S. New, Postmaster

General of the United States, was the discontinuance of 705 trains carrying United States mail, operating over a total of 39,716 miles, and the consequence of which was that 462 United States post offices—serving a population of 352,671 people—were without mail service.”

All of the losses which the Attorney General has figured are those which were borne by the railroads, or by the industries which are dependent upon the railroads for the delivery of materials and for the distribution of the finished product, and no consideration has been given to the losses suffered by the striking shopmen. From the figures given it appears that in the neighborhood of 260,000 shopmen must have been out of employment on the fifty railroads during the duration of the strike.

Assuming that these men earned an average of \$5.00 a day, the daily loss to the workmen amounted to \$1,300,000.00. When this sum is increased to include the loss of wages by the shopmen who were out on the great number of railroads not included in the Attorney General's statement, it will be readily seen that a very heavy share of the total loss fell upon the workmen.

These figures make it evident that it is to the interests of both employer and employed to make every effort to adjust their difficulties without resorting to a suspension of work. The principal cause of strikes is a flaw in the personal relations between men and management and nothing will go farther toward preventing the enormous economic loss which results from such interruptions of operation than an improvement all up the line in co-operation between the men in the ranks and the men in executive positions.

As has been frequently said, the foreman who is in constant and direct contact with the workmen, is the man who must assume the greater part of the burden for the quality of the personal relations between the rank and file and the management. The foreman understands the workman's viewpoint, and he should be fully informed as to the policy of management, and it is his business to reconcile the two.

160. Co-operative Programs.

The necessity for closer co-operation between men and management is becoming very generally understood, and many plans are being tried out to effect this purpose. In the industrial field the plan of giving the employes a voice in the management of the business through the agency of shop councils or similar schemes, has been on trial for a number of years with varying success.

These experiments have been carried far enough to indicate that the success or failure of the plan depends, not so much upon the character of the plan itself, as upon the capacity of the men on both sides to forget their own individual interests and to co-operate for the best good of the organization and the business as a whole.

In the railroad field one outstanding experiment in Co-operation is that which has been in process of development on the Baltimore & Ohio Railroad for some time. This plan is too new yet to permit the formation of accurate conclusions as to what the ultimate results will be, but it is sufficiently interesting to be worthy of study. The principal features of this plan are set forth as follows:

"1. The development of periodic joint conferences between local management officers, such as master mechanics, superintendents of shops, their supervisory staffs and the regularly functioning local federated committees of the crafts concerned. These regular local conferences to be supplemented from time to time by occasional and eventually regular conferences between the chief mechanical department officers and the system officers or general chairmen of the federated crafts.

"The subjects to be considered at these local and system conferences are not to be grievances, working rules or wages, but rather ways and means of bettering maintenance service, output, quality of work, employee recruiting and training, stabilization of employment and morale. The adjustment of grievances, rules and wage matters, it is intended, shall be handled precisely as they always have been in the past.

"2. The development of a general understanding by all concerned, union men, union officers and railroad officers, of the relation between labor costs, wage rates, continuity of work, and productivity, so that the gains resulting from co-operation will be determined and properly taken into consideration in future wage adjustments. A typical formula recognizing this understanding, for example, is the following one:

"The welfare of the Baltimore & Ohio Railroad and its employees is dependent on the service which the railroad renders the public. Improvements in this service and economy in operation and maintenance expense result chiefly from willing co-operation between the railroad management and the voluntary organizations of its employees."

"When groups responsible for better service and greater economy share fairly in the benefits which follow their joint efforts, improvements in the conduct of the railroads are greatly encouraged. The parties to this agreement recognize the foregoing principles and agree to be governed by them in their relations.

"3. The development of a program of employment stabilization upon (1) railroad work in railroad shops consistent with railroad shops' ability to do such work more economically, better or quicker than can be done elsewhere, and (2) creation of maintenance reserves and a system of yearly budgeting of maintenance expenditures so as to avoid sudden, violent and wasteful fluctuations in production and employment.

"4. The establishment of employee service clearing centers, whereby employees of the normal working force who are temporarily idle at one or more points, can be utilized elsewhere so that the railroads will not lose their investment in the training and adaptation of these employees and facilities, and so that employees will see that really sincere efforts are being made to give substance to a program of employment stabilization.

"5. The development of improved employment methods, whereby the co-operating railroads will receive their share of the most skilled and competent mechanics available.

"6. The development of improved methods of recruiting, educating, and training apprentices."

To give a more comprehensive idea of the scope and intention of this B. & O. plan, the following details are quoted from an article in the *Railway Age*:

"Briefly, the agreement recognizes three fundamental principles as essential to the success of co-operation. These are as follows:

"1. The recognition of the standard shop crafts unions as organized and affiliated with one another on the Baltimore & Ohio as necessary, constructive and helpful agencies in the running of the shops, repair yards and roundhouses.

"2. The equitable sharing between shopmen and railroad of the gains of co-operation.

"3. The stabilization of employment.

"The first principle, above, in accordance with the agreement, is given real meaning through the organization, effective March 5, 1924, of bi-weekly joint co-operative meetings at all the important points on the system. The local management will be represented by the local officer in charge, i. e., superintendent of shops or master mechanic and his staff. Included in his staff among others, will be the local storekeeper and the local chief of the Shop Practice Bureau, if one is functioning at the point in question. It was considered essential to the success of co-operation that the railroad supply service be 'in on' these bi-weekly conferences, for as is well known, an efficient material supply service is indispensable to a well managed shop.

"The establishment of a fixed Shop Practice Bureau at each major shop point, such as Mt. Clare, Cumberland, and Glenwood, together with a traveling shop practice service for the minor shop points such as Newark, Washington, and Garrett, is also a feature which has grown out of the co-operative program. By means of these bureaus and services the management is enabled promptly and effectively to put the useful, constructive, practical ideas and suggestions emerging from the joint co-operative meetings into practice. For the management to be ready to do this when interest in improved service is rife, is considered absolutely essential for the sustaining of the interest in improved service.

"Further, in keeping with the first principle, the agreement provides for tri-monthly joint co-operative system meetings between the chief of motive power and equipment or the general superintendent of motive power and staff representing the management, and the executive board of Baltimore & Ohio System Federation No. 30, representing the shopmen. Careful minutes will be kept of all meetings, local and system, copies of which will be furnished to the general mechanical department headquarters at Baltimore, department headquarters of Lines East and West at Baltimore and Cincinnati, respectively, system federation headquarters at Cincinnati, and the local officers and federation concerned.

"The subjects to be considered by these local and system co-operative meetings will have chiefly to do with such matters as shop, yard and roundhouse operation, material supply, distribution, care and saving; methods of doing work, job analysis; quality of work performed; co-ordinating, scheduling, routing and planning of work; group and shop performance records; conditions of shops, grounds, tools, equipment, and facilities, and shop and department morale. But above all else, as the 'Memorandum Agreement' indicates: 'Suggestions and ideas advanced will be given fullest consideration, having in mind that the specific purpose of these meetings is mutual helpfulness and not criticism and faultfinding.'

"The second principle, fair sharing of the gains of co-operation, is to be realized through improvement in working conditions and wage income, as resulting from the day-by-day betterments following intensified co-operative efforts, and from occasional negotiations with management based, among other things, on actual showings made through co-operation. Neither piece work, bonus nor task systems of any kind are intended as the ultimate method of reward for the co-operative effort of the shopmen.

"Methods of wage payment on the individual or piece basis, the Baltimore & Ohio shopmen contend, destroy the most fundamental requirement of efficient and economical shop operation, namely, the closest possible co-operation between man and man,

gang and gang, department and department. Under a piecework system, it is their contention, everybody is for himself, with the railroad getting the hindmost.

"The provision of the agreement recognizing the foregoing principle of reward is quoted in a previous paragraph.

"The third principle, 'steadier work' is to be carried out by doing Baltimore & Ohio work in Baltimore & Ohio shops, the extension and improvement of Baltimore & Ohio repair and manufacturing facilities, and by such other measures as time and future experience may indicate as being wise and necessary. The management has agreed to develop a program step by step along the foregoing lines, especially in so far as co-operation results in lowering repair and manufacturing costs, thereby justifying the management in doing work in Baltimore & Ohio shops in preference to purchasing materials and equipment from outside concerns.

"Proposals, ideas, and suggestions by the local shopmen for consideration at the joint local co-operative meetings, the spokesmen for the organized workers contend, will naturally come to life through daily contact with the work. The mechanics in the shop, taken as a whole, are full of useful ideas and a basic desire to be helpful in bettering things around shops. It is simply, their spokesmen maintain, because the average railroad shop organization makes no practical provision for releasing the ideas of the average man in overalls, but instead rather successfully suppresses the fundamental co-operative instinct of the shop worker, that this most valuable of all potential assets of the human part of our railroad shops is utterly lost.

"It is the conviction of the Baltimore & Ohio shopmen and their leaders that the co-operative shop conference plan, based as it is upon genuine recognition of the men's own local and system federated shop committees, is the most promising method yet devised for releasing these latent assets and applying them to the good of the Baltimore & Ohio, its patrons, and employees. At all events, the Baltimore & Ohio System Federation officers point out, the value of the regular union federated shop committee men as the contract representatives of the shopmen with

management for the purpose of improving shop performance, was fully and indisputably demonstrated by the way Pittsburgh Local Shop Committee No. 10 functioned in joint co-operative conference with Glenwood shop management. The fact that the Glenwood joint co-operative committee idea has been extended to the entire system indicates that the federated shop crafts on the Baltimore & Ohio have demonstrated the truth of the foregoing theory to the satisfaction of the management.

"The instructions which the headquarters of Baltimore & Ohio System Federation No. 30 have sent out to each local lodge and shop federation constituting the system federation in respect to the handling of matters to be considered at the joint co-operative conferences by the representatives of the shopmen are interesting and illuminating. The letter to the membership, which carries these instructions, reads in part as follows:

" 'Proposals, ideas, suggestions, etc., by the local shopmen for consideration at the joint co-operative conference will naturally come to life through our daily observations in and around our jobs, benches, machines, departments and shops. Such ideas, suggestions and proposals on the part of our men should be referred to their local craft committees for handling. In this connection we would suggest that the local shop committee of each craft get together occasionally at noon time or some other time convenient to all concerned and acquaint itself with various matters and suggestions referred to it by our local members for submission to the next local joint co-operative committee meeting.

" 'We suggest further, when each craft holds its local lodge meeting, the individual members bring their ideas for bettering things, jobs, output, conditions, etc., to the lodge room for consideration, discussion and subsequent reference by the lodge to the proper craft committeeman for handling at the next co-operative meeting, provided, of course, the idea receives the endorsement of the lodge. In general the same procedure should be followed in getting important matters considered by the joint co-operative committee, which we now follow in the handling of grievances. Whenever the subject advanced by anyone is

important enough, the lodge might well discuss it at its next meeting, so that your representative at the joint meeting will have the full benefit of your experience and judgment. In short, the regular union channels should be used at all times in getting matters before the joint meetings for consideration. Depending upon the importance of the proposal, the local shop committees may refer it directly to the joint committee meeting through the local craft representative, or the local committee may first refer it to the next lodge meeting and even perhaps the local shop federation meeting, for discussion and action. By following this procedure the ideas of every one will get fair and adequate consideration.

“It is not the intention to utilize the joint co-operative meetings for the adjustment of grievances. Grievances, when they do arise, should be adjusted immediately and not allowed to hold over. Furthermore, the mixing up of disputes on matters growing out of the violation of our agreement or working rules, with the consideration of measures intended to help improve the shop and its operation will tend to confuse the purpose of these co-operative meetings, will delay consideration of grievances and in general will lessen the usefulness and opportunity of the joint co-operative meetings.”

It remains to be seen whether or not the Baltimore & Ohio plan of co-operation will bring about the results which are desired, but whatever the result, the movement is a step in the right direction, and its development should be watched by every shop executive who is interested in the improvement of the personal relations between men and management on his railroad.

The fact that the higher officials of the Baltimore & Ohio have been impressed with the possibilities of this plan as it is being developed in their mechanical department is indicated by the fact that the same plan is being extended to the transportation and maintenance of way departments.

161. The Co-operative Principle.

There is little doubt that the co-operative plan as it is being worked out on the B. & O. is sound in principle, but its adoption

on other railroads in exactly similar form is a matter which is subject to a number of conditions. Not all railroads deal with the federated crafts, and on some it would be difficult to persuade the general officers to go into a co-operative scheme of the proportions of that just outlined. But, while a general co-operative plan for the entire railroad is a very desirable thing, and one which may eventually be adopted on all of the railroads, there is much which can be accomplished by local co-operation between shop management and shop men. The carrying out of such a plan, by a foreman in his department or by a shop superintendent in his plant, independent of what may be done by other shops or departments, is a matter deserving of attention.

CHAPTER XXV

CO-OPERATION IN PRACTICE

162. Experiments in Co-operation.

A strike is always a deplorable occurrence, both from the standpoint of the men and of the management. It is not only the monetary loss, suffered by employees and employers alike as a result of the suspension of work, but the more serious and lasting effect of the controversy upon the relations between the management and the men, which make the occurrence of a strike an event to be avoided if in any way possible.

The most recent general strike of railroad shopmen brought forcibly to the attention of railroad owners, employees and the public at large, the need for some method of improving co-operation within the railroad organizations so as to minimize the probability of any further serious controversies in the future.

Many of the railroads in the past two or three years have gone farther into the problems of co-operation than they have ever done in the past and it may be expected that, in the immediate future, many schemes, having for their object the improvement of the relations between men and management will be devised and tried out.

The plan adopted by the Baltimore & Ohio Railroad has been discussed in some detail, but the importance of the subject justifies the employment of further space in describing, briefly, the steps which have been taken by other railroads to improve the quality of co-operation.

The problem of personal relations is one which the railroad executive should give the most exhaustive study. The efficiency of railroad operation depends almost entirely upon the efficiency of the human organization and every officer of the railroad

should devote a substantial part of his time and effort to the study of this problem from all possible angles.

The plans to improve co-operation which are being tried out by the several railroads at the present time are all more or less experimental and the results which may come are problematical. The fact that this program is in the trial stage is all the more reason why railroad executives everywhere, should follow the results closely so as to appropriate for their own lines any beneficial features which may be developed.

It should be understood that the success of any co-operative program rests mainly with the foremen and other executives who are in direct, daily contact with the working forces, rather than with the higher officials, who can devise plans but who are not in a position to carry them into successful effect. The individual worker knows his foreman, and if the leader is thoroughly competent, the man has confidence in him and respect for his opinions. The worker does not know the general manager, the superintendent of motive power or the president and cannot be expected to look upon these officials with the same degree of confidence that he gives to the man whom he knows personally.

Mr. W. B. Storey, President of the Santa Fe, tells this story on himself. It appears that he was making a trip over the lines, and at one of the important division points visited a barber shop. While seated in the chair, a brakeman came in and one of the barbers remarked that he had heard that Mr. Storey was in town. The comment of the brakeman was, "Who the hell is Mr. Storey?" The brakeman would have been quick to recognize the name of the superintendent, or the master mechanic, or the trainmaster, but the name of the president of the road by which he was employed meant nothing to him whatever.

Whatever results are secured from programs designed to improve relations within the organization will depend upon the spirit in which the foremen and shop and division officials interpret the policy to the men, and upon the active interest which these officials take in promoting the propaganda of good will.

163. The Union Pacific Plan.

Following the strike the Union Pacific employees in the mechanical department organized a Shop Employees' Association and as a result of negotiations between representatives of this organization and of the management, a shop agreement was adopted with the object of promoting co-operation. While this agreement dealt with wages and working conditions, it went farther, and set up a basis upon which it was hoped to interest the individual employee in other matters of mutual advantage to men and management. One of the provisions of this agreement is worded as follows:

"To the end that the employees may receive the full benefit of co-operation with the company and that both parties to this agreement may equally profit thereby, each individual member of the association is to feel and understand that it is not only his duty to himself and his fellow employees and the company, but his privilege to call the attention of his local committee to:

"(a) A suggested change in location of machinery or equipment or of any other shop appliances or of added protection thereon which might result in a greater degree of safety to the employees or of increase of efficiency or economy in operation.

"(b) To the general surroundings which might be arranged so as to lead to more healthful surroundings or to a greater degree of comfort to employees, and

"(c) In a general way to any question or factor which, as the individual views the situation, may be so handled as to result in the mutual advantage of the employees and the company.

"The local committee will investigate each such matter to which their attention is called and, if in their judgment it is meritorious, they will handle with the proper official or officials who will give careful consideration thereto, and should it be decided that action is justified, it shall be done. A record will be made of all matters handled to a conclusion, including the action taken, a report made thereon through the general manager's office to the System Board of Adjustment, and proper reference will be made thereto in the board's annual report."

In order to develop the benefits intended by this provision of the agreement a program of meetings at shop points was inaugurated, at which accredited representatives of the Employees' Association and of the management get together for free discussion of matters brought up by the employees. These experimental meetings proved successful and the interest manifested justified the further development of the plan. As a result these meetings are now conducted under a regular order of procedure which has been made standard for all points on the system. The procedure specified for the conduct of these shop meetings is of sufficient interest to warrant quoting in full.

"1. The meetings shall hereafter be known as shop councils.

"2. Shop councils shall be held once a month at each shop where not less than fifty employees represented by the Shop Employees' Association are regularly employed, provided that, where in the judgment of the superintendent of motive power, meetings should be held at points having less than fifty men, he be authorized to arrange such meetings.

"3. The shop council shall be held on date of each month and shall begin at hour mutually arranged by the chief supervising officer and the local chairman of the Association at that point. The date and hour shall be so fixed that shop councils thereafter may be held on the same date and hour in so far as possible. When date for shop council falls on Sunday or holiday, the following day shall be substituted.

"4. The chief supervising officer, or designated representative at each shop or point, shall attend each meeting of shop council. The supervising officer shall make necessary arrangements to the end that the maximum number of his subordinate officers may be in attendance at each meeting.

"5. All local committeemen who are employed on shift during which shop council is held, shall attend each meeting unless one or more of the committeemen are at that time employed on work which they cannot leave. No deduction in time will be made for committeemen on account of attending the shop council. Local committeemen employed on other shifts should attend

shop council meetings, but the attendance of such committeemen will be without expense to the company.

"6. Officers other than those included in the above paragraph (4), and employees other than those included in the above paragraph (5), may attend meetings of the shop council.

"7. At each meeting of the shop council held subsequent to the first meeting held under these rules, the chairman of the next meeting shall be selected. The chairmanship shall alternate from meeting to meeting between one of the officers and one of the committeemen.

"8. Minutes shall be kept of the proceedings at each meeting and will be signed by the chairman and the secretary of the meeting. The minutes shall show:

"(a) Place and date shop council was held.

"(b) Names of those attending:

"(1) Officers and official title.

"(2) Committeemen and craft or class of each.

"(3) Others present.

"(c) Subjects discussed and action taken.

"9. The order of business at each meeting shall be as follows:

"(a) Reading of minutes of preceding meeting, showing action taken thereon.

"(b) Suggestions that may lead to safer practices or more comfortable or more healthful surroundings.

"(c) Suggestions that may lead to greater economies in operation or to increased efficiency.

"(d) Differences of opinion arising under the application of the agreement that have been handled up to, but not inclusive of the officer in charge of that point, provided the local chairman of the craft or class of employees affected has filed notice of appeal on the question which he desires to have handled with said officer at least three days prior to date meeting is held.

"(e) Shop problems of local management.

"(f) Other new business.

"(g) Unfinished business.

"(h) Discussion of questions or matters in which the employees and the management are mutually interested.

"It is further suggested that from time to time association officers and railroad officials higher in rank than those regularly attending the shop council be invited to attend and address the

council; also that prominent local citizens be occasionally invited to address the shop council.

"10. Copies of minutes of the shop council will be distributed in accordance with instructions of superintendent of motive power and machinery, except that the secretary of the council will forward copies directly to the secretary of the System Board of Adjustment and to the secretary of the lodge having jurisdiction over the employees at the particular shop or point involved.

11. The minutes of the shop council shall be read under the head of Order of Business No. 14, 'Debate—Good of the Association,' at the first subsequent meeting of the lodge after receipt. Lodge members should discuss these minutes with a view of bringing to the attention of the local committeemen such matters as they believe should be the subject of further consideration at the next shop council.

"12. Not to exceed 2 hours and 30 minutes are to be consumed in each shop council meeting. In order to assist the council secretary in securing necessary information in order to comply with provisions of section 9 (h), those in attendance will fill out a slip with necessary information thereon, and hand same to the council secretary at the end of the meeting.

"Based on the minutes of the meeting the proper supervising officer may apply corrective measures, or issue such instructions from time to time as he may deem necessary and within his province.

"It is to be understood that questions usually discussed at official foreman's meetings will be handled under section 9 (d) and that such meeting will be considered as the foreman's meeting for the week."

In announcing the establishment of the shop councils, the president of the Shop Employees' Association offered the following pertinent remarks:

"From the foregoing it is plain to be seen that the Union Pacific System is enlarging on a work that, without question, has at least been a contributing element in bringing about a better relationship and understanding between the management and all of its employees.

"This enlargement means added and special opportunities to the committeemen and others who may and should attend, to develop in a way that has never been possible before, and for that purpose I wish to draw the attention of our readers to several of the preceding paragraphs.

"Paragraph 5 of the instructions states that all committeemen available on that shift shall attend and that there will be no deduction in their time for such attendance. This means an added expense to the management, but is done to help cement that feeling of confidence between management and men that has existed for one and one-half years and to strengthen the feeling of joint responsibility in keeping the wheels of this great institution, the Union Pacific System, rolling efficiently in the interest of the public.

"You will note that committeemen on other shifts are invited to sit in on their own time. This opportunity should be taken advantage of as far as it is physically possible to do so, inasmuch as the individual will be benefited as well as the Association.

"Paragraph 7 calls for the alternation of the chairmanship of the shop council. Before a child can run it must first walk; and the arrangement referred to is going to be the opportunity for a man to begin walking in another line of work, that of presiding over a meeting.

"Paragraph 9 (d) gives special opportunity to have an open discussion of questions in dispute that have been appealed to the highest authority at the place so as to get the best and clearest understanding possible of the vital points involved and, therefore, the real merits of the case. And to the end that no time be wasted in useless discussion, I will ask all of our men to study and know our agreement.

"Paragraph 9 (h) gives exceptional opportunity to men to develop their powers of reasoning and speech, and by applying themselves to the study of some of the subjects that are to be presented they will be benefited to an extent that is little dreamed of at present.

"To my mind the chance to develop mentally and morally far exceeds in importance that of momentary advantage, though it is true that the advance in dollars and cents that accrues to the working man by collective action instead of personal ability is appealing.

"Paragraph 11 is a suggestion that it is hoped will be made use of to a very great extent, because by giving publicity to the doings of the committeemen in the shop councils the lodge members will also be in a position to benefit thereby."

Representatives of the management of the Union Pacific and of the employees, without exception, express satisfaction with the workings of this co-operative plan and advance the opinion that the improved understanding established between men and management will go far toward improving the efficiency of operation and toward terminating labor friction in the future.

164. The Pennsylvania Plan.

The Pennsylvania Railroad employs more men than any other railroad in the world and earns revenues far above those of any other line in the United States. It is doubly interesting, therefore, to note the steps taken by this great road to solve the most difficult of all the problems of railroad management.

The fundamental features of the Pennsylvania plan may be described as follows:

1. An opportunity for all employees to have a voice in the management in matters in which they are directly concerned (wages, working conditions, etc.,) through employee representatives elected by themselves regardless of whether they are union or non-union members.

2. Establishment of a mutually satisfactory method of promptly settling all controversial questions arising between management and men.

3. Establishment of a joint tribunal for each class of employees equally representative of employees and management which is the final arbiter in the disposition of industrial disputes.

The operation of the Pennsylvania plan is conducted through the agency of committees of employees who meet regularly with the local officials. Any matter which cannot be settled by these local committees and the division officers is referred to the higher officers. If an agreement cannot be reached between the employee committees and the general manager, the controversy is referred to a joint committee, upon which the management and the men are equally represented.

It will be seen that the plans adopted by the Union Pacific and the Pennsylvania differ from the Baltimore & Ohio plan in several essential features. On the Pennsylvania and the Union Pacific all questions of wages, working conditions and general conditions are handled by the committees, while on the Baltimore & Ohio wage and grievance controversies are handled in the regular way, by negotiation between the officers of the company and the accredited representatives of the unions, and the joint committees devote their entire attention to matters of mutual interest outside of those referring to wages and conditions of employment. The Baltimore & Ohio plan is more democratic in nature than are the others, but its scope is less comprehensive.

It will be interesting to follow the development of these various plans during the next few years. It is not likely that any one plan will ever be developed which will give uniformly good results on all railroads, and while certain features may be applicable to all conditions, the details of any successful plan must be worked out to fit local conditions. The railroad mechanical departments have taken the initiative in the introduction of co-operative schemes and mechanical officials everywhere should follow with particular interest the reports of results secured.

CHAPTER XXVI

SELECTION OF MEN

165. Turnover.

Labor turnover has been the subject of intensive study by the management of factories for a number of years past. The railroads are just beginning to understand the importance of the matter and it may be expected that in the near future they too will endeavor to devise schemes to prevent the enormous yearly waste which results from the constant necessity for the employment and training of new men to take the place of those who leave the service or have to be discharged.

It has been variously estimated, by engineers who have made an exhaustive study of the matter, that it costs all the way from \$30.00 to \$200.00 to break in a new man and that \$1,000.00 is a low price to pay for the training of a new foreman. These are factory figures and it is very likely that the cost of training new men for railroad work is very much higher. In most factories the work is highly standardized and specialized, and it is only necessary to teach each individual workman to efficiently perform a small number of uniform operations. On the railroads, and particularly in the railroad shops, standardization and specialization can only be carried out to a very limited extent. Even though men are assigned to special classes of work, as they should be and usually are in the larger shops, no two repair jobs are identical, and the individual workman must be depended upon to use initiative and judgment, besides applying a high degree of mechanical knowledge to the completion of his daily work.

It is impossible to figure, accurately, the rate of labor turnover in the mechanical department of a railroad, but cases are known of individual shops where the rate runs as high as 300%

a year. This means that to maintain a force of 1000 men, 3000 must be employed each year. If the cost of training each of these 3000 men averages the low figure of \$100.00, the loss to the railroad would total the important sum of \$300,000.00 a year.

There are, of course, many reasons why men leave the service of the company or must be discharged and it is too much to hope that turnover can ever be entirely eliminated. It is possible, however, materially to reduce the number of men hired and fired and every such reduction means increased efficiency of operation.

166. Selection.

The most effective measure which can be taken to reduce the force turnover is to improve the method of selecting new men. It is a well-known fact that the total turnover occurs in a comparatively small percentage of the force. In most shops from 70 to 90 per cent of the men are "home guards" and may be depended upon to stay with their jobs month after month and year after year, so long as they are fairly treated by their superiors. The whole trouble is with the remaining 10 to 30 per cent of the men, who are constantly quitting for some reason or for no reason at all, or who are either incapable or unreliable and must be discharged if they do not quit.

The responsibility for the heavy turnover on the railroads in the past lies partly with the managements, which have followed the practice of alternately reducing and increasing forces to correspond with the rise and fall in the volume of business. That the higher officials of the railroads are beginning to realize the evil which results from this practice is indicated by the fact that many conferences have been recently held to devise plans for the stabilization of labor requirements. If the Interstate Commerce Commission can be induced to co-operate with the railroad managements, by permitting them to set up reserves in the good years to provide against drastic curtailment of maintenance work when revenues are low, it is very likely that, within a short time, a plan will be worked out whereby shops can be kept in operation and track forces fully employed season

after season and year after year, regardless of fluctuations in business, but until a change in accounting methods is authorized, by the Commission, there is very little that railroad managements can do to obviate the necessity of reducing forces and expenses whenever the volume of business falls off to a serious extent.

The problem of stabilizing general conditions is in the hands of the management and the foreman and even the superintendent of motive power has no choice but to reduce forces when he is called upon to curtail expenses, and to increase them when business demands that shop work be speeded up, but every officer should understand why such fluctuations are necessary and should do his best to minimize their effect upon the efficiency of the forces under his supervision.

To illustrate the importance of this factor of labor turnover, certain statistics prepared by the Interstate Commerce Commission are of interest. The following statement shows, for various dates, the total number of men employed by the Class I railroads.

Date	Number of men
Average 1917	1,737,876
Average 1919	1,913,422
Febr. 1920	1,970,525
Sept. 1920	2,197,824
May 1921	1,543,716
Nov. 1921	1,755,136
Febr. 1922	1,545,040
Nov. 1922	1,820,463
Aug. 1923	1,973,505
June 1924	1,770,565

These fluctuations in force follow very closely the increase and decrease in the business handled by the railroads, and serve very well to illustrate employment conditions on the railroads as a whole, as they are influenced by the variation in revenues. If the railroads were permitted to set up reserves when business

is good to provide for the payment of wages when times are hard, it would be easily possible to so plan the work of the mechanical and roadway departments that working forces could be kept constant. Under present conditions, forces are reduced when revenues are low, and the general condition of the motive power and rolling stock grows worse than average; when the volume of traffic increases, the railroads employ all of the men they can get and work the forces overtime in order to catch the deferred maintenance. The result is inevitable. Maintenance charges are excessive, on account of the necessity for the employment of inexperienced men, and the payment of overtime rates, the quality of the work turned out is inferior, and shop and road organizations are demoralized through constant breaking up of the routine.

It should be understood by foremen and by the men in the ranks, that under the present system of control as set forth in the Transportation Act, the railroads are only permitted to earn a certain fixed percentage each year on their capitalization, and that any profits in excess of this amount must be returned to the government. Under this provision of the law the railroads cannot set aside any reserves in the good years to provide against depressions, and until the law is amended or the Interstate Commerce Commission authorizes a change in the accounting system the railroad managements are powerless to correct the condition.

General business conditions are not, however, the only nor perhaps the most important factor contributing to a high percentage of force turnover. Many men are hired and discharged every day, whether business is good or bad, because of conditions over which the local managements have more or less control. In the more progressive factories the employment of workmen has been assigned to a special department and every effort is made to select only such men as will fit well into the organization, who may be expected to develop fair efficiency, and who seem likely to stay on the job.

It is hardly likely that the employment methods developed in the factories will ever be generally introduced on the rail-

roads. While it is possible to establish employment departments at the larger shops and to relieve the department foremen of the duty of selecting and hiring men, such a procedure would not be possible at the smaller shops and at the roundhouse points. It is further true that it is impossible to closely standardize the requirements for labor on a railroad as is possible in a factory and for this reason the procedure in the future must be much the same as in the past. The department foreman must be depended upon to select, employ and train his own men.

One of the most important duties, then, of the foreman is to select the workmen necessary to fill out his force, and this is a duty which should not be subordinated to any other. The reason for the employment of undesirable men is, usually, that the foreman, crowded with other duties, does not take the necessary time to interview applicants and to decide whether or not they will fit properly into his organization. When the foreman needs a man, the usual procedure is to question briefly the available applicants and if their experience, as stated by them, seems to qualify them for the job they are put to work. It may be days or even weeks before the foreman discovers that the man employed is lacking in ability, in character, or in some other quality desirable in an employee and by that time the employee may have cost the company hundreds or even thousands of dollars in wasted time, spoiled work, or bad influence on the remainder of the force.

The time to pick out the undesirables is before they are employed and not after they have wasted the company's money and the foreman's time. One hour spent in selecting the proper man for the job may well be the best spent hour of the day.

There has been a great deal written and said about the science of employment, and some over-theoretical authorities have attempted to clothe the subject in mystery by the use of psychological terms and expressions for things which, said in plain language, would be easily understood. In truth there is no secret about the proper method of selecting men and the best judges of the capabilities of men are the practical executives who have learned by experience to size up the individual, and

not the highly trained and scientific psychologist who insists upon applying specified tests to determine the rate at which the applicant's muscles respond to brain impulses.

Some men, it is true, are better judges of human nature than others and these will have greater success in the selection of suitable workmen, but any executive who will give the proper time and attention to the subject will find that his ability to select good men may be developed.

It is not always the best mechanic, by any means, who makes the most desirable employee, nor is experience the only measure of a man's worth. Many of the very best mechanics in the country are "boomers" by nature, but the man who has worked for short periods in many places is seldom a desirable employee. The very fact that a man does not hold a job long indicates that there is something in his makeup which unfits him for a place in a permanent organization. An average man who will stick to the job year after year is always a better man than the exceptional workman who may be expected to quit any payday.

There are always many young men in a shop, apprentices and helpers, who are influenced by the talk of the much-traveled "boomer," and when such men get into the organization they are very likely to start some of these young men out on the road, to the disadvantage both of themselves and of the shop.

The policy of the progressive railroad should be to train and promote its own men. Taken straight through, a man who has served his time in a shop, who has social connections in the town, who has grown up in the spirit of the shop, is a much more efficient and desirable employee than any man who can be hired from the outside.

CHAPTER XXVII

THE FOREMAN'S JOB

167. What Foremen Think.

We have learned in America to have the greatest respect for the opinion of the practical man. While we have the greatest technical schools in the world, and while these schools are yearly turning out graduates who are of great value in the industrial world, it is none the less true that our progress as a business nation has rested upon the efforts of the practical rather than the technical men.

Everywhere, at the head of industries of all kinds, are found men who have come up through the ranks, who have gained their knowledge of the business through actual experience coupled with intensive study.

It is certain then that the opinions of practical men should carry great value for the student, a value which he cannot get from schools nor from books written by men of purely technical mind.

We must all appreciate the value of technical knowledge; the trained engineer and the chemist have their proper and important place in the industrial scheme, but there is a wide range of subjects upon which the view of the practical man, who has made some success, is far more valuable than that of the most learned college professor.

In order to give the student the benefit of the experience of men who are close to the job, men who are every day handling the problems which come before every foreman, the following extracts are quoted from papers read by the General Car Foreman, the Blacksmith Foreman, and the Machine Foreman of the Billerica shop of the Boston & Maine, at a recent foreman's meeting.

168. The General Car Foreman's Remarks.

"The busiest and hardest working man in the railroad shops today is the foreman, provided he is on the job. These positions demand, in the first place, knowledge of what work should be done, how it can best be performed under the existing conditions and when it has been sufficiently and satisfactorily completed to meet requirements.

"What is of more importance, a foreman must know how to get along with and how to handle his men. He must also maintain a certain dignity without conveying the impression that he is without feeling and sympathy for the men working under his direction. He is the one who comes in direct and personal contact with his men; therefore he is the man who personally represents the management with the men. He should be fair in all of his dealings, should have no favorites nor show any partiality. A foreman has to act as a judge every day; therefore, he should be just. The foreman should be exact in his promises and should always try to keep them.

"The foreman should not waste anger. Use it. Anger is valuable and should not be used carelessly. A foreman should keep his most forceful language for special occasions. He should not use snap judgement in settling a dispute, always hear the other side, never blame a man until he is given a chance to give his side of the story. Don't hold spite. Be quick to forgive. Whenever you have to scold a man, go to him later and show him his fault in a friendly way. Never show discouragement. Never let yourself be beaten.

"Foremen must always have perseverance and the 'never say die' spirit. Always notice the good points in your men as well as the bad. Let the men see that you can appreciate as well as condemn. Place each man where he can do the most work. Always take your full share of the blame. The foreman who can share both blame and praise with his men has discovered the secret of success in handling men.

"Try to prevent accidents. Educate or eliminate the careless man. A good foreman is known by his men. Don't feel too big

for your position, for you cannot tell but the man under you may be able to fill your position as well or maybe better if given the opportunity.

"The day in which a man's value as a foreman was measured by his ability to force men to perform a greater amount of work in a day than they otherwise would have done is past. The need is not so much for drivers as it is for leaders of men today.

"Don't let your men loaf around the shop. Whenever you see any of your men standing around talking to the other men, go right up to them and see if there is anything that can be done to keep them at work. Find out what they are waiting for and get them back on the job just as quickly as possible.

"The foreman is the connecting link between the management and the men. He is the key man and the top sergeant who receives the policies and orders from his superior and passes them along to the men under his direction. It is his job to convert plans into production. To do this he must know how to handle men. He must understand the company's policy and must be able to pass it on to his men in a manner that they will understand; in other words, he must be a leader of men. He must have executive ability.

"No man can attain leadership without paying the price for it. He must be willing to study. The present-day foreman cannot employ the old driving tactics and hope for much success in his efforts. Too often the foreman promoted from the ranks has become overbearing and hardened in his treatment of his men. If the foreman is cheerful, loyal and efficient the men under him naturally tend to become that way, also.

"The foreman who is unfair or a tyrant will do more damage to an organization in a day than his influence and production can do in a year. The successful foreman of today must be a human engineer and must be able to get confidence and good will. He must understand that his job is to try to educate the men under him. Education, therefore, must begin with the foreman, from him it should reach the men. The outstanding need in the railroad shop today is the foreman who not only knows what is to be done and how to do it but who also knows how

to convey that knowledge quickly and surely to the men under him. All men cannot be handled alike. Some have got to be practically forced to do service, but the majority can be made to accomplish more by a kind word of encouragement from time to time."

Here is a sermon on foremanship which covers in a few paragraphs nearly every important point which needs to be covered. Here are the boiled-down opinions of a man who knows what he is talking about, who has made a study of his job and has discovered the essentials of successful leadership.

169. The Blacksmith Foreman Speaks.

"A more systematic method should be used to instruct the foreman, so that he can and will make the men under him feel that the officials have the interests of the individual at heart and that, no matter what happens, he will get a square deal.

"The personality of the foreman should be such that he will be approached by his men with their confidences, both as to happenings inside and outside the shops, and asked for advice. When this is done, the foreman will soon see that he has an organization that is for him and when they are for him it means that they are for the company as a whole. He can instill such a feeling into the men that should reverses of any nature come to the railroad they do not say first of all that the officials are to blame, but are still for a square deal for all.

"A foreman should at all times do unto others as he would like to be done by—this also applies to the officials. The days of driving have gone and men have got to be handled in an individual way, as the dispositions of no two men are alike. It is up to the foreman to find out the peculiarities of each of his men and to handle them accordingly. This can be done where there is supervision enough, so that a man will not supervise more than twenty-five men. With more men he has not enough time, either properly to instruct them in their duties or to get to the man's personal makeup in such a way that he can make a booster of that man.

"Every employee has the makings of a good man who would fit in somewhere in some department if someone could find the way of turning on the necessary spark. No one can find this more quickly than the foreman who comes in contact with him at all hours of the day.

"There has always been too much of the old-school method of continually looking for a chance to get something on the foreman or man (who has, in the first place, not received the training he should have) so that he can be bawled out, with a threat of being discharged, instead of helping the foreman and man involved, to profit by the mistakes so that he will feel like saying, 'I have got to hit the ball in such a way that these things will not occur again.' A discouraged foreman or man cannot give satisfactory service, and when either the man feels that he cannot go to his foreman or the foreman feels that he cannot go to his superior and frankly talk over truthfully any occurrence, whether a mistake or not, without being bawled out or threatened with dismissal, he is going to try to cover it up in some way. This treatment should be discouraged and a spirit of confidence instilled in all so that they will be hitting the ball from all angles.

"More attention should be given to training all the foremen in all the problems of the railroad, as it is through them that the men will be enlightened and happenings and matters that should be carried by them to the public at large, whose good will we have to cater to at all times. A satisfied supervisor means many satisfied men, and a satisfied supervisor can only be had by studying his particular problems and his disposition and makeup and trying to help him, instead of helping to increase his dissatisfaction to the point where he becomes discouraged.

"It all sums up that some method should be devised whereby proper training can be given the foreman, so that he can carry out the policies of the railroad, as they should and can be carried out through him."

Here again is an expression of opinion from a man who has gone deep into the problems of his profession. This foreman

realizes the importance of his position, he appreciates the responsibility which he bears, to his men, to the management and to the public.

170. The Machine Foreman's View.

"When I think of what my attitude towards the men working under me should be, I find myself looking back to the time when I was being instructed in the work of railroading at the old Boston shop, some twenty-seven years ago. The men who were finding fault all the time and were impatient with our shortcomings brought out the worst in us; and naturally working under unfavorable conditions, we failed to give them our best work. Men cannot do their best work under such leadership. But those who were calm and sympathetic and ready to help us correct our mistakes gained our confidence, and we worked for them with interest and zest.

"This does not mean that a foreman has to be hail-fellow-well-met with his men, but he must inspire them with confidence, have infinite patience, and bear in mind at all times that the best men make mistakes sometimes. A man should be human and bear in mind at all times that oftentimes home conditions such as sickness, financial difficulties and misunderstandings make a good man temporarily unfit.

"If a man makes a mistake, don't jump on him before you find out where the fault lies. It may be that he did not know how to do the work and therefore the fault was yours for not instructing him before he started; or perhaps you have been impatient with him so that he did not like to ask you how to do the job.

"Never go round with a grouch on, so that the men under you hesitate to go to you at all times for information concerning their work. Do not continually find fault with your men's work but let them always feel that just as long as they do their best you are satisfied.

"I always like to have plenty of work ahead for a man, so that he always knows what his next job is going to be; also to

have two or more men doing the same class of work, as it creates rivalry, a spirit of competition which keeps things moving.

"I sometimes ask a man to keep track of the time it takes to do a certain piece of work. He may stop you to tell you that it took him one hour and fifteen minutes; but that he believes that he can do it the next time in one hour; and even better than that. At the same time I make some suggestion as to a jig or other device that could be made to facilitate matters, and get him to think it over and see if he can find some way to do it more quickly. In this way you have gotten him interested in his work, and you will find that he is producing more work and that his efforts are having an effect on men about him. If the men get thoroughly interested in their work, results are bound to be good. Make them feel that they are a part of the railroad.

"If a man does not co-operate in this spirit and fails to produce the work so that you have to go over the same ground with him daily, he is either not suited to the kind of job he is on, or is hopeless, and the sooner he is transferred or dropped the better for him and for the company.

"Be firm and just but always sympathetic."

In these three brief talks on foremanship by foremen who are daily practising the gospel they preach, will be found the whole essence of the art of managing men. The student will note that these men emphasize the necessity of justice in all dealings with the men; of sympathetic understanding of their problems, both in and out of the shop; of firmness and of patience.

Going back to the words of the railroad president, previously quoted, it will be found that the advice given by the General Foreman, the Blacksmith Foreman, and the Machine Foreman, while differently expressed, is exactly identical with that given by the man who has risen from the ranks to the highest position in railroad management. This fact is significant in that the agreement of opinion between the president and the foreman leaves little doubt that the formula outlined is that by which men reach success in the handling of men.

CHAPTER XXVIII

PROMOTION

171. The Essentials of Progress.

There are just four essentials to progress up the railroad ladder. These are:

1. Ambition.
2. Energy.
3. Good Character.
4. Study.

It is essential, of course, that a man should have the ambition to rise. Progress in any line is not to be made without effort, and the man who hopes to better his position in life can only do so by putting forth special and persistent effort. The path of least resistance is to accept the day's work and the day's wage and give no thought to tomorrow.

A number of years ago the Burlington was building an extension in Montana. Labor was scarce and one of the contractors conceived the idea of hiring Indians from a neighboring reservation. These bucks would furnish their own teams and work for a dollar a day, but they must be paid in silver every night. Each Indian would work about every third day, as the dollar would buy whisky and tobacco enough to satisfy him for that period. Some white men are a good deal like Indians; they want their wages and what they will buy, and nothing more.

On the statute books of Nature is a law of compensation. Nothing which is worth having can be obtained without effort and sacrifice. The man who only does enough to "get by" will only get by, if he succeeds in doing that. Probably no man was ever born lazy, but the habit of idleness is very easy to acquire, and like every other bad habit is hard to break.

The energy with which a man goes at his daily task is largely dependent upon his liking for, and his interest in, his work. Drudgery and hard work are not synonymous. The performance of any distasteful task, however easy, is drudgery; to work hard on a job which absorbs the interest is a pleasure. The man who succeeds in any line of endeavor must have energy inspired by genuine interest.

Good character is a business, as well as a moral, asset. The average man has a high ethical standard, and while he may himself have occasional lapses in which he does things which he knows to be wrong, he loses respect for any other man who does not live up to the accepted code. The man who has become, or expects to become a foreman or higher executive, is in a position where his actions are watched and judged, both by the men above and below him. His effectiveness as an executive will depend upon the respect in which he is held by the men under his supervision, and his prospects of promotion will be increased or decreased with the reputation which he bears.

Character, as here used, is not applied in the narrow sense of personal morality, although morality in itself is an asset, but in a wider meaning of the term which implies self-control, good judgment and fairness. The man who cannot control his temper will never be able to handle men effectively, for the angry man has neither judgment nor fairness. The foreman is a leader and a teacher and as such he must set the example which he wishes to have his men follow. If he is hasty and unjust, his men will be secretive and unloyal. If he holds his temper on all occasions and is fair in all of his dealings he will have the respect and confidence of his men.

Good character implies loyalty. There are some employers for whom a self-respecting man cannot work, but any man or company which is worth working for at all is worth working for loyally. In these days of powerful propaganda against big business in general, and the railroads in particular, it is not unusual for the man in the ranks to form the opinion that he is working for an industrial octopus which seeks to squeeze from him the maximum of effort for the minimum of remuneration. The man

who holds to such a belief cannot be loyal, and his lack of this necessary quality will prevent him from ever being an efficient executive.

To the man in the ranks, the foreman represents the management, and the man's opinion of the company for which he works will be based, largely, upon his opinion of his immediate superior. In the old boomer days, now past but not forgotten, certain shops were known as good places to work, while others were marked, as tramps mark gates where there is a bulldog within, as good places to stay away from. The good shops got the good mechanics, while the bad shops got the men who could not work in the good shops. Whether a shop is a good shop or a poor shop to work in depends upon the character of the foreman who is in charge and not upon location, or facilities or equipment.

The foreman is just one step out of the ranks, and he understands the viewpoint of the worker better than the higher executive does. The man who has risen to one of the higher positions in the management has lost touch with the psychology of the shop, which is a thing of constant change, and unless the foreman makes himself an interpreter between the man in the ranks and the man in the management, there will be misunderstanding and friction. It is said, by those who have made careful investigation, that practically all labor trouble starts with a disagreement between minor officers and the men. One of the principal values of the labor union is that it protects the individual workman against unjust treatment by the foreman directly over him.

All through the pages which have gone before and through those which will follow, the importance of study for the man who is ambitious to rise has been and will be mentioned again and again. This reiteration is justified by the importance of the advice. In any line of business constant study is one of the most important essentials of success. The boy who graduates from law school is competent to begin an apprenticeship in the practice of law, but if he becomes and remains a successful lawyer he must continue to study every year of his life. In the

mechanical trades, development is very rapid; the standards in methods and materials which obtained last year are no longer up to date, and the man who does not constantly keep pace with progress is a back number before he realizes it.

The progress in the methods of management is even more rapid than in purely mechanical methods and the executive has the double task of keeping informed as to the development in both lines. "Scientific management" has a formidable sound, but it is, in truth, nothing more nor less than the application of common sense to the solution of industrial problems. Frederick Taylor, who was the originator of the system known as "scientific management," was first of all a practical mechanic who knew from intimate contact the problems of the shop. His development of the high-speed machine tool was his greatest accomplishment, and is a development the value of which every mechanic appreciates. The introduction of a new and more efficient tool into shop practice called for the adoption of a system which would insure the proper use of the superior equipment.

High-speed steel tools cost many times as much as the old carbon steel tools and their use can only be justified by increased output per labor hour. In order to be sure that such an increase in production was accomplished, Taylor and his followers introduced into shop practice operation and cost studies. The cost studies were necessary to prove that the new and higher priced tools were more economical than the old tools, and the operating studies were made to insure the use of the most efficient methods of machine operation. The world owes a great debt to Frederick Taylor. The system which he introduced has been one of the great factors in making large quantity, low cost production possible, and low production costs have meant higher wages and cheaper luxuries.

172. Training a Successor.

Not infrequently a good man is kept on a particular job because there is no suitable material available to replace him. Vacancies may occur in higher positions, and men of less ability

may be promoted to fill them, while the good man is held down because the organization as a whole would be weakened by the necessity of placing an inferior man in the lower but no less important place which he occupies.

The lesson in this case is that the individual foreman should not only strive to make himself competent for the next position ahead but that he should train the man next below him to take his place when the time comes for him to move up. Many a general foreman has been promoted to master mechanic or shop superintendent only to find that he must shoulder a double burden by helping and supporting the incompetent man who took his place in addition to assuming the duties of the higher office.

Andrew Carnegie, who made one of the greatest fortunes of the past century, was able to do so, not on account of his own great knowledge of the steel business, but because he had an unusual faculty for selecting and training men who could handle the management of the business for him. The capacity of a single man to accomplish results is strictly limited; it is the accumulated and co-ordinated effort of many men which makes the successful operation of a great business possible. The foreman cannot get results unless he has the co-operation of good men, the shop superintendent will not be successful unless he has a staff of good foremen.

173. Ruts.

The road of life is rutted like a country highway after a heavy rain. Once a man's wheels are sunk to the hub in the tracks of those who have gone before him, it is a difficult task to get out again onto the smooth road where progress is sure and fast. Habit and precedent are powerful forces and their tendency is always to retard progress. The monkey and the parrot are great imitators, but their usefulness in the world is nil.

The man in the rut may be a good worker; he may do excellent work along the lines which he is following; but when it comes to promotion he does not stand the same chance as the less competent man who has the initiative to constantly improve

the methods of performing his given allotment of work. One of the first things which the foreman should do, when he begins to study the elements of his job, is to analyze his daily work to determine whether he is merely following the track beaten by his predecessor or whether he is applying the knowledge which he gains from study in making himself a more important factor in the organization.

The order of the day is Progress, and a man must either keep step or fall behind. New methods and practices are constantly being introduced on the railroads. Nearly all of these innovations have some merit to recommend them and the wise and progressive man keeps an open mind so that no possibilities for improvement may escape him. When air tools were first introduced into the shops they met with hard opposition from men and foremen who were deep in the rut of precedent, and many a good old boilermaker stayed in the ranks because he persisted in the belief that the only way to drive rivets was with a hand hammer.

174. The Virtue of Patience.

It is difficult to be patient, to wait for the things which we long to have. For the ambitious man it is difficult to see the months and years pass without bringing definite progress. But nothing which is worth having comes easily. The man who seeks promotion in the railroad organization has years of work and study ahead of him, and even when, in his own opinion, he has reached the state of experience and knowledge which should entitle him to a better position, there may be a long delay before his opportunity comes. Many good men have ruined their prospects by impatience. When promotion did not come promptly they have changed jobs, hoping for better luck in another shop, and usually they have found that in their new place they were further from hope of advancement than in their old.

Dissatisfaction is a powerful force in the world. Properly directed it is the force behind all progress, wrongly applied it leads to destruction. Dissatisfaction is of two kinds. One kind

leads the man to put forth every effort to improve his condition. If Coolidge had been satisfied to stay on his father's farm he would never have been President of the United States. No man should be satisfied with his job but his discontent should take the form of a determination to improve his condition by study and application. The form of dissatisfaction which leads a man to grouch and shirk his work prevents him from progressing and gains him nothing.

CHAPTER XXIX

EXPENSE RATIOS

175. The Operating Ratio.

The final test of the efficiency of operation of any business is the relation between revenues and expenses. On the railroads, this relation is called the operating ratio, and is arrived at by dividing the total expenses of operation by the total revenues from operation. The operating ratio varies widely on the different railroads and for different years on the same railroad, just as the profits of any business fluctuate with the increase and the decrease in the volume of business and with the rise and fall of labor rates and the cost of materials.

It is the business of the management of a railroad to endeavor to keep the operating ratio at a point sufficiently low to provide a margin between revenues and expenses to take care of interest on borrowed funds and dividends on invested capital. During the past few years this has been an increasingly difficult task. Rates are definitely set by action of the Interstate Commerce Commission and cannot be increased when business is bad or when expenses are unavoidably increased. The prices of all the materials and supplies which the railroads must buy, to repair equipment, to renew roadway and to supply the innumerable needs of the many departments, constantly fluctuate and the general trend has been upward. Labor rates increased enormously during the war and have decreased but little since its end, nor can they be reduced to meet any temporary slackening of business. With these conditions existing, it is evident that the railroad managements have been hard put to it to keep the properties solvent.

The general officers of the railroad watch closely the operating ratio, as it varies from month to month, and this figure

is the index which indicates to them the necessity for reducing expenses. When the operating ratio rises to a point where expenses threaten to consume a part of the revenue which should be set aside for the payment of taxes, interest and dividends, the management has no choice but to call upon the operating departments for a reduction in expenses. If the general officers do not act in time the railroad goes bankrupt and everyone concerned, stockholders, bondholders and employees, stand to share the resulting losses.

When orders come down the line to curtail expenses and when the appropriations of the several departments are reduced, the reason for such action can almost invariably be found in a rising operating ratio.

By reference to the chapters on Railroad Accounting it will be seen that operating expenses are classified under five general heads, i. e., Transportation, Maintenance of Equipment, Maintenance of Way and Structures, General, and Traffic. Each of these heads represents the expense of a separate department and all together go to make up the total cost of operating the railroads. In the statistical reports of the railroads the expense of each department, as represented by these general accounts, are shown as ratios of the total operating revenue, and the efficiency with which the various departments are handled is judged, largely, by whether these ratios rise or fall. The executives of the various departments should, therefore, follow very closely the fluctuations in the ratio, so as to anticipate the action of the general officers, and to be fully prepared when the call comes for a reduction in expenses.

176. The Transportation Ratio.

The operation of a railroad is so complicated and the work of the several departments is so intimately related that the ratio of expense to revenue of any single department may mean little or nothing, unless all of the conditions of operation have remained nearly constant. The transportation ratio, which represents the relation between the cost of operating trains, stations, yards, of handling engines and a large number of other less

important items, and the total operating revenue, may be increased or decreased by a variation in factors which have little if anything to do with the actual efficiency of the management of the transportation department.

For example, when motive power of improved design and greater power is purchased and put in service in the handling of trains, the transportation ratio may be substantially reduced, because the larger engines will haul longer trains at less cost per ton mile for fuel and for wages of train and engine crews. Such a decrease in the transportation ratio is due to improved equipment efficiency and not in any way to the efforts of transportation department officials or men. When grades are reduced, curves straightened or general roadway conditions improved the transportation ratio is automatically reduced, even though the actual efficiency of the transportation department may remain unchanged.

It is evident then that the mere fact that the transportation ratio rises or falls is not a sure indication of improved efficiency in train operation, and the credit may be due entirely to the maintenance departments rather than to the transportation department. It is apparent, then, that officials of the mechanical and track departments are interested in the performance of the transportation department as well as in that of the departments over which they have direct supervision.

Transportation expenses may be increased, on the other hand, by relatively poor condition of motive power or rolling stock, or by bad track or weather conditions. The responsibility of the roundhouse foreman, the repair track foreman, the shop foreman and the master mechanic for creditable performance in the handling of trains is no less than that of the chief dispatcher, the trainmaster and the superintendent, and this fact should be appreciated by every executive in the mechanical department from the gang foreman to the highest officer. No department of the railroad is independent, and this is particularly true of the transportation department, but each must depend upon all of the others, which is the important reason that co-operation, not only within departments but throughout

the entire organization, is the most important essential of efficient operation. While the ratio of maintenance of equipment to revenues may be taken as a fairly accurate gauge of mechanical efficiency, and the ratio of maintenance of way to revenues as an index of the quality of supervision in the track department, the transportation ratio indicates the combined efficiency of all the operating departments in almost the same degree as does the operating ratio.

Transportation expenses consume a greater proportion of the revenues than do those of any other department and are, therefore, of the greatest relative importance. The fact that mechanical officials have little or nothing to do with the actual operation of trains should not lead to the conclusion that they should not interest themselves in the transportation ratio. Some of the expenses incurred under the head of conducting transportation come under the direct supervision of mechanical executives. Enginehouse expense, for example, is one very large item which is charged directly to the transportation accounts, and the men and materials charged to this account are under the absolute control of the roundhouse foreman. Supplies and lubricants for locomotives are other items entirely in the hands of the mechanical department. One of the largest single items of expense in connection with railroad operation is that of fuel for locomotives and economy in this item is largely in the hands of the mechanical executives.

Aside, however, from the fact that a part of the expenses charged to the transportation accounts are incurred in the mechanical department, there is a more important relation between the efficiency of the shops and roundhouses and the transportation ratio than that represented by the actual expenditures to these accounts. The efficiency of train operation and its cost are largely dependent upon the condition in which the locomotives and cars are kept. Every engine or car failure piles up transportation expense in the form of wages of delayed crews, and every reduction in tonnage, due to the inability of locomotives to handle their full rating, means a higher transportation cost per ton mile and per dollar of revenue.

Many attempts have been made to figure the cost of an engine failure, but the proposition is entirely too complicated to permit its reduction to an average which would anywhere near represent the truth under all conditions. On a busy railroad a single engine failure may cost thousands of dollars in delayed traffic, and even though but one train is laid out the expense amounts to an item of importance.

It is evident, then, that the superintendent of motive power, the master mechanic, the shop or car foreman, and the round-house foreman should be interested in the transportation ratio, quite as much as is the general manager, the superintendent and the trainmaster.

Transportation ratios vary widely on different railroads, depending partly upon the nature of the traffic handled, partly upon the efficiency of the transportation department, partly upon the nature of the equipment and facilities, and partly upon the character of the support given to the men who actually operate the trains by the other departments.

On a road which handles a large amount of coal, ore, or other heavy commodities which lend themselves readily to heavy car and train loading, the transportation ratio should be relatively low, while maintenance of equipment and maintenance of way expenses may be correspondingly high, due to the fact that large power units are expensive to maintain and that heavy power and equipment create excessive wear on tracks and structures. On roads which handle mostly merchandise and the lighter, bulkier products, the transportation ratio is usually high, because heavy tonnage trains are out of the question. The railroad which handles a large passenger business in proportion to the freight traffic will also have a high transportation ratio.

It is evident, then, that the transportation ratio of one railroad cannot be compared with that of another unless the conditions under which they operate are closely similar. A ratio of 40% might be good for one railroad, while a ratio of 30% might be very poor for another. There is always danger in comparing the performance of one railroad with that of another unless all of the conditions of operation are taken into consideration and

this fact makes it very difficult to set up equitable standards by which to measure the general performance. The best comparison which can be made on any railroad is of present with past performance, and the management which constantly improves its ratios need not worry about what other railroads are doing.

The mechanical man should watch the transportation ratio with as much interest as he does the maintenance of equipment ratio and should demand credit or assume blame for increases or decreases for which his department is responsible.

177. The Maintenance of Equipment Ratio.

In years past, when locomotives and cars were light, the cost of their maintenance, as an average for all railroads, ran about 14% or 15% of revenues and were approximately equal to maintenance of way expenses. With the great increase in the size of power units, and with the application of numerous devices such as stokers, superheaters, feed water heaters, boosters and brick arches, the cost of maintaining engines has steadily increased in proportion to other expenses and to revenues, until, at the present time, maintenance of equipment expenses take up more than 20% of all the money earned by the railroads. In January, 1924, the actual maintenance of equipment ratio for the Class I roads was 22.3% and even that high figure was more than 1% less than for the same month of 1923. The fact that such a large proportion of railroad revenues is spent for the maintenance of locomotives and cars will give the mechanical man some idea of the important place which he occupies in the railroad organization.

The increase in the maintenance of equipment expenses has, of course, been largely offset by corresponding or greater decreases in the cost of conducting transportation. It is evident, however, that with the improvement in equipment design, the job of the mechanical department executive becomes daily more important, in that he is intrusted with the expenditure of increasingly large sums of money.

The fact has been frequently emphasized in other chapters, that standards of measurement of performance are essential to

efficient administration. Such standards are not easy to set on the railroad, where a large number of factors enter into each item of performance. A low cost of maintaining power is not an indication of high efficiency unless the condition of the locomotives is such that, at all times, they will handle trains at the minimum cost for transportation expense. A low cost of car repairs, when a large percentage of the equipment is in bad order, does not mean economy, as all of the saving in direct charges to the car repair accounts is lost in higher figures for per diem on foreign equipment, in train delays and in loss and damage claims for lading injured in transit.

As a general unit, for a single railroad, the ratio of maintenance of equipment expense to revenues, is the best index to the relative efficiency of the mechanical department and it is a figure with which every mechanical department executive should be familiar.

Where conditions remain fairly constant, that is, where there is no change in the class of power operated or in the conditions under which it is operated, the mechanical department should endeavor to keep the maintenance of equipment ratio constant or, if possible, to reduce it. The ratio will, of course, vary from month to month and from year to year with the fluctuation of business, but the average level should be maintained. It is comparatively easy to reduce the maintenance of equipment ratio when business is heavy and locomotives and cars are being worked to their full capacity, as the increased revenues from the heavier business handled will more than take care of the increment of expense, but when business is declining and revenues falling off the problem is much more difficult.

It should always be remembered that a very ordinary man can handle a business when everything goes well, but that the real value of an executive is shown when everything goes wrong. The mechanical man who can run a department or a shop or a division when business is good and there is little limit placed on expenses is not hard to find, but the man who can keep up the power and handle the force without difficulty when business is bad is the one who gets and deserves the greatest credit.

178. The Division of Maintenance Expense.

The larger part of the money spent by the mechanical department is for the repair of locomotives and cars and it is these accounts which must be most carefully watched. Economy and efficiency are both matters of infinite detail and the old adage which says, "Take care of the little things and the great ones will take care of themselves," applies with equal force in the shop and roundhouse as elsewhere. It is the extra hour of work used on one job and the unnecessary piece of material drawn for another which add up into a total of inefficiency.

It cannot be too firmly impressed upon the mind of the foreman that constant attention to detail is the most important essential of creditable performance. Mr. Harrington Emerson, the noted efficiency engineer, says that many men are only 20% efficient, and in making this statement he does not refer to laborers but to executives. It is no doubt true that all of us waste a large part of our time in doing things which need not be done or in doing things in an inefficient way, so that we do not secure the results that we should for the amount of effort which we expend. It is not how hard a man works, but how intelligently, that measures the quality of his performance.

A man may slug all day on a frame bolt without so much as moving it. He has worked hard but the result of his effort has been nil. The same man with an air motor might have drilled the bolt out in an hour or so, or with an oxy-acetylene cutting torch he might have burned it out in a few minutes. The man with the sledge worked hard, but his method was inefficient; the man with the air motor and drill would have been performing the job efficiently if the cutting torch had not been available; but the man who burned the bolt out would be using the most efficient known method and his performance would, therefore, reach the highest possible standard.

Efficiency, then, is not a matter of how hard the individual works, but rather of the effective use he makes of the appliances and facilities placed at his disposal.

The personal efficiency of the foreman will be reflected in the efficiency of his department; if the foreman wastes his time, his inefficiency will be multiplied by the number of men in his department and the total result will be department inefficiency. The foreman's duty is not only to see that every man under his orders employs his whole time while in the shop, but that he uses the most efficient methods and the most effective equipment.

In the consideration of locomotive repairs, with which the mechanical man is principally occupied, the student should give attention to the relation between classified and running repairs. In the Interstate Commerce Commission classification of accounts no division is made between the expenditures necessary to keep engines in serviceable condition while in service and those required to complete general overhauls. Most railroads, however, make some division in their own accounts between running and shop repairs, but the line is not very definitely drawn and the figures for one road cannot be compared with those of another.

It is unfortunate that more detailed statistics as to the cost of equipment repairs are not available as such information would be a valuable guide to the mechanical executive in measuring the performance of his department. It is to be hoped that in years to come some improved methods of dividing expense and of computing cost will be originated and introduced on the railroads, but in the meantime the mechanical man must depend upon the meager and inaccurate figures with which he is supplied and supplement them with such units as he himself can establish for his department. It should be understood that figures, in themselves, are of absolutely no value and that the most complete and accurate accounting in the world is valueless unless the accumulated data are used by the executives in direct charge of the work.

The best measure of shop and roundhouse efficiency, as applying to the cost of locomotive maintenance, which is at present available, is the cost of repairs per unit of service rendered. This unit is difficult to apply unless the accounting department makes a division of repair charges between engines

used in passenger, freight and switching service, in which case repair costs may be figured on a passenger car mile, ton mile and service hour basis for the respective classes of service. If a further division of expense is made between running and classified repairs the mechanical executive has a very fair basis upon which to measure the efficiency of the shops and roundhouses.

Whatever figures are or are not available the mechanical man who hopes to advance in the service should not be content to go without some basis by which to measure the performance of his department.

179. The Value of Ratios.

The thoroughly practical man is rather too much inclined to look with disrespect upon figures as something with which theorists play, but which have little actual value for the man on the job. It must be admitted that this attitude is more or less justified by the fact that many of the data which are furnished are of little or no value to any one. However, the attention of the man who is inclined to despise statistics as such, is called to the fact that the insurance business, which is one of the greatest in the world, is based entirely upon statistics which deal with the most variable of all things, human life. The insurance business has grown to enormous volume during recent years, hundreds of millions of dollars are yearly collected from policyholders and vast sums are paid out to beneficiaries. The premiums charged on insurance policies are carefully computed upon the expected length of life of the average individual and the fact that these figures work out with great accuracy is fully proven. While there are a great many insurance companies in the field, and while the competition for new business is severe, all of the great companies are prosperous, although the margin of profit upon which they work is very small. When such a thing as the average life of man can be reduced to a reliable estimate there is no reason why definite ratios cannot be established to cover such a comparatively simple thing as the proper relation between revenues and expenses in any branch of business.

The principal object of this discussion is to point out to the prospective executive the value of figures and of ratios and to interest him in such statements as may come to his attention. In some branches of the railroad service it might, perhaps, be difficult to interest the men in figures, but the mechanic, whose very trade is based upon exact measurements, should have little difficulty in comprehending the meaning of columns of figures, of averages or of ratios.

180. The Annual Report.

Every railroad prepares for its stockholders each year what is known as the "Annual Report." The reports of some railroads are very complete and comprehensive, showing the revenues and expenses in detail, accounting for all expenditures for new equipment and facilities, and giving statistics as to performance. Many of the railroad executives are furnished with copies of these annual reports and they should be placed at the disposal of all foremen and other executives.

The annual report is made for the purpose of advising the stockholders fully as to the financial standing of the railroad and as to the disposal made of its revenues. It is no less important that the employees of the road should know what the general results of their efforts have been, and men in executive positions should take pains to analyze the figures presented so that they may be in a position to pass on to the men in the ranks the facts as to the condition of the company which employs them.

The foreman in the shops should never lose sight of the fact that he is the representative of the management and that it is his business to know how the affairs of the company stand. In order to understand the policy of the company it is necessary to know what interest payments must be made on funded debt, what sums must be set aside for taxes and other expenses outside of those incurred in actual operation, and what amounts may be set aside for improvement of the property. It is frequently stated that one of the important duties of the railroad executive is to interpret the policy of the company to the men under his

supervision, but no man can interpret a thing which he himself does not understand.

Some workmen remain workmen all of their lives, although they may be exceptionally good workmen; some foremen never rise above that rank, although they may be thoroughly competent in the position which they occupy. The fault for such a condition is invariably with the individual. The man who does not progress, or who rises a certain distance only to stop there, is the man who has not taken the time or the trouble to study the job of the man ahead or to inform himself as to the policies of the company so that he may show by his performance an active and intelligent interest in the betterment of conditions about him.

CHAPTER XXX

DESIGN OF RAILROAD EQUIPMENT

181. The Locomotive.

The equipment of a railroad must be fitted to the traffic which it is to handle and to the conditions under which it must operate. The Erie and the Virginian can make good use of great triple engines with a tractive power equal to that of two or three ordinary freight engines, but such power would be worse than useless on the Long Island or the V. S. & P. There is no advantage to be gained by placing heavy locomotives on light rail, or by putting heavy section rail under light power.

The first factor controlling the design of power most suitable for a certain railroad is the nature of the traffic to be handled. When coal and ore are the principal commodities to be handled locomotives of great tractive power and low speed must be employed. Such traffic as this carries a very low rate, and in order to realize a profit, the railroad must handle it in long heavy trains so that the cost per ton may be kept below the revenue.

Railroads which handle mostly grain and other comparatively light but bulky commodities are limited as to the size of the power which may be profitably used. Heavy Consolidations, Santa Fe type, or even Mallets, may be used to advantage, when it is possible to get sufficient tonnage behind them without running trains of unreasonable length. Other things being equal, the more tonnage behind the locomotive the lower the cost per ton mile, but there are definite limits to the application of this principle. Whenever train lengths equal or approach the length of sidings the movement of all traffic is slowed up, and slowing up means greater expense. On single or even on double track the long drag is likely to get in the way of other traffic and

cause more expense in delays than it saves in the handling of heavy tonnage to the train.

When there is much high-speed traffic, such as fruit and live stock, to be handled, the freight power must be designed for speed as well as power. Most of the greater railroads handle many classes of traffic and power design must be varied to suit this condition, although there is a distinct limit to which this profitably may be done. The more classes of engines a railroad owns the more difficult and expensive will be their maintenance, and it does not pay to save money in transportation cost at the expense of the maintenance accounts.

The design of power which is best fitted to the needs of any particular railroad can only be determined by an exhaustive study of all the conditions of operation, and the making of such studies is the constant duty of the railroad executive and particularly of the mechanical man. The design of power is being constantly improved and the mechanical official who fails to keep up with the most recent developments is not doing his full part in the efficient management of the railroad.

Every railroad is in the market every year or so for new locomotives to take care of increasing business or to replace units worn out in service and it is the business of the mechanical man to see that the power purchased is of the best design to fit the needs of the traffic. In order to make intelligent recommendations as to the design of power which should be purchased the mechanical man must be well up on all of the conditions of operation and this is one of the reasons why the executive officer, or the foreman or workman who expects to become an officer, should make a study of all factors of operation not only in his own department but in all other departments.

182. Locomotive Classification.

Locomotives are grouped in general classifications according to their wheel arrangement, as illustrated by the chart on a following page. This classification is, of course, of the most general nature as there is a large variety of designs for each of the wheel arrangements. A 4-6-2 engine, for example, may

be single expansion, or it may be of any of various compound types, it may be piston valve or slide valve, it may have any one of a number of valve motions, and in fact the entire design from the frames up may vary on engines with an identical wheel arrangement.

Many railroad men who are not yet past their prime can remember the time when the standard eight-wheel and the ten-wheel engine represented practically all of the power in service on the railroads. Today we have everything from a 0-4-0 to a 2-8-8-8-2 and it would take great assurance to prophesy what changes and improvements may come in the next quarter of a century.

Development of locomotives in the past has been largely along experimental lines. New types of power have been designed, built and tried out. Some have been abandoned as impractical or inefficient, while others have had sufficient merit to hold them on the list of possible designs, some few have proven their right to a permanent place in the transportation scheme. The problem of the future mechanical official, probably, will be more along the line of perfecting and refining present designs of power and rolling stock than of developing new models.

The master mechanic, or the foreman, or the man in the ranks should not get the idea that the perfection of the design of locomotives or cars is a matter with which he has nothing to do. Locomotive builders and technical men employed by the railroads are constantly studying and experimenting in an endeavor to improve existing types of power and to devise new types which may prove more economical and efficient, but their best efforts are of little effect except when co-ordinated with those of the men who actually handle, repair and operate the engines when in service.

It is safe to say that a locomotive was never built which did not look perfect on paper, but a very large number have been designed which were not worth the room they occupied in the shop. Every mechanic knows, from his own experience, that there is a vast difference between theory and practice. The

machine which appears flawless on the drafting board may develop innumerable defects when constructed and put to work. The part of the designer and the engineer is to develop plans along the best theoretical lines, that of the mechanical official is to detect and point out weaknesses and, if possible, to suggest improvements.

183. Service Records.

The final test which must determine the design of power best fitted to any railroad is the quality of the service which it gives. Elaborate tests with scientific appliances to determine hauling capacity, fuel consumption, water evaporation and all the other data dear to the heart of the engineer are all very well and proper and necessary, but figures and charts and curves mean nothing at all unless their evidence is supported by the performance of the engine when it is put to the daily task of hauling tonnage. The value of a locomotive, as a machine for producing transportation, is measured entirely by the cost of its operation on a ton mile basis.

The master mechanic or foreman in charge of the power on a division knows, or should know, just what each unit is capable of doing. He should know the fuel consumption, the tonnage performance, the failure record and the repair cost on every engine operating on his territory and if he does know these things he is in a position to suggest improvements in design which would never come to the mind of the engineer.

Practically every railroad keeps more or less elaborate service records on its locomotives, but the value of these figures is only realized when the operating officers make the best possible use of them in improving performance. A record of fuel consumption by individual engines is a valuable guide in detecting improper drafting or poor grate or ash pan arrangement. The engine failure record, when carefully studied, discovers weaknesses in design or improper specifications for materials and suggests improvements which mean better service and greater economy. Repair cost records, when carefully kept and properly analyzed, are of great value in determining the

best methods of shop procedure and also direct attention to weakness of design or construction.

184. The Car.

The ever-increasing power of locomotives is rapidly making kindling wood of the few remaining all-wood box and passenger cars. Only a few years ago a 40-ton car was above the average, while at present 120-ton cars are not infrequently seen. Wood construction has given place to steel underframes and all-steel cars, and the end has by no means been reached.




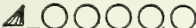









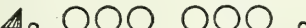






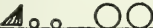


Designs of cars have been vastly improved but they must be still further improved to keep pace with the development of heavier and more powerful power units. The freight car is the best money earner of the railroads, but in order to contribute its share of the revenue it must be rolling over the road. The constant demand is for greater mileage per car day so that earnings may be increased with a minimum investment in equipment. A good average mileage per car per day is partly a matter of operating methods and partly of well designed cars kept in good condition.

Mr. Vauclain, the head of the Baldwin Locomotive Works, pays a doctor to keep him in good health. This is a plan which has long been followed by the Chinese, who pay their doctors so long as they are well and do not pay them when they are ill. Foremen of shops and repair tracks should be paid on this same basis, if it were possible, so that their wages would increase when the pits and tracks were empty and decrease when they were full of cripples.

The mere repairing of cars which are disabled in service is not the full duty of the car foreman. Although his hands may be full with the actual supervision of the work of the shop, he is not preparing himself for higher positions in the management if he fails to devote a part of his attention to the study of the design and construction of the equipment which passes under his eye with a view to discovering the weaknesses which bring the cars to the repair track when they should be in revenue earning service.

There is no education which compares with practical experience when coupled with intelligent study. The railroads have been developed to their present state of perfection by practical men who have worked up through the ranks, supplementing the knowledge gained from experience with that acquired by study of the best authorities in their line of work. The future improvement of power and rolling stock on the railroads is in the hands of the foremen and the workmen who will climb to the higher executive positions as the older men step out. The man who expects to rise must, therefore, not only know the routine of his trade but must be prepared to handle the larger and more intricate problems of general policy.

WHYTE'S CLASSIFICATION OF LOCOMOTIVES

040		4-WHEEL SWITCHER
060		6-WHEEL SWITCHER
080		8-WHEEL SWITCHER
0100		10-WHEEL SWITCHER
0440		ARTICULATED
0660		ARTICULATED
0662		ARTICULATED
0880		ARTICULATED
010100		ARTICULATED
2440		ARTICULATED
2660		ARTICULATED
2880		ARTICULATED
2442		ARTICULATED
2662		ARTICULATED
2882		ARTICULATED
210102		ARTICULATED
240		4-COUPLED
260		MOGUL
280		CONSOLIDATION
2100		DECAPOD
440		8-WHEEL
460		10-WHEEL
480		12-WHEEL

WHYTE'S CLASSIFICATION OF LOCOMOTIVES (Continued)

042		4-COUPLED AND TRAILING
062		6-COUPLED AND TRAILING
082		8-COUPLED AND TRAILING
044		FORNEY 4-COUPLED
064		FORNEY 6-COUPLED
046		FORNEY 4-COUPLED
066		FORNEY 6-COUPLED
242		COLUMBIA
262		PRAIRIE
282		MIKADO
2102		SANTA FE
244		4-COUPLED
264		6-COUPLED
284		8-COUPLED
246		4-COUPLED
266		6-COUPLED
442		ATLANTIC
462		PACIFIC
482		MOUNTAIN
444		4-COUPLED DOUBLE ENDER
464		6-COUPLED DOUBLE ENDER
446		4-COUPLED DOUBLE ENDER
286		8-COUPLED DOUBLE ENDER

CHAPTER XXXI

LOCOMOTIVE PERFORMANCE

185. The Function of the Locomotive.

Mr. A. G. Pack, Chief of the Bureau of Locomotive Inspection, speaking at a meeting of the Traveling Engineers' Association in 1924, described the functions of the locomotive in the following words:

"The locomotive is the heart of transportation and serves the same function for the railroads as the heart does for the body. Unless the heart acts efficiently the blood ceases to circulate freely and the limbs become paralyzed; unless the locomotive is maintained in a high state of efficiency, the arteries of transportation clog and business becomes stagnant and confused."

The performance of the locomotives on a railroad or on a division is one of the larger factors which determine the efficiency of operation as a whole. During the busy season of almost every year, the newspapers and the railroad journals give much space to what is called the "car shortage." In truth there would seldom, if ever, be a car shortage if the condition of power generally were such that trains could be put over the road in reasonable time, and if locomotives could, in all cases, be furnished to handle tonnage when the cars are ready to move.

There are a great many factors which contribute to a car shortage, such as delays in loading and unloading by shippers and consignors, poor condition of rolling stock, bad car distribution, and the locomotive cannot be charged with all of the blame for slow movement. An important share of the responsibility for the expeditious movement of traffic must, however, rest upon the motive power and upon the men who handle and repair it, and so long as the average daily mileage of engines is below the

attainable standard, the mechanical department is not doing its full share in keeping the business of the railroad moving.

The expenditures which the railroads are able to, or are permitted to make in the purchase of new equipment are strictly limited, and even though it were possible to buy an unlimited number of locomotives and cars, their presence on the railroads would not solve the transportation problem. Only a certain number of trains can be handled over a given piece of line, and any increase in power and rolling stock above a fixed point would mean no advantage whatever in the handling of a greater volume of business.

Primarily, then, greater efficiency in operation is not a matter so much of increased facilities and equipment as of better use of that already provided. The railroads, as financial considerations permit, are constantly purchasing more powerful locomotives and larger capacity cars, but the effectiveness of this investment depends entirely upon the method with which the new equipment is handled by the mechanical and transportation forces.

186. The Value of a Locomotive.

A locomotive traveling one hundred miles a day, hauling a train of one thousand net tons of revenue freight, which carries an average rate of one cent a ton mile, would earn one thousand dollars a day. With the operating ratio at 75%, the net earnings of the engine, above all expenses of upkeep and operation would be \$250 a day. There are many locomotives which haul far more than one thousand net tons and their earning power is correspondingly greater. There are a greater number of freight engines which do not handle one thousand net tons and their earning capacity is, of course, less. Any student who is sufficiently interested, can figure the earning capacity of the freight engines operating on his division or railroad, by merely multiplying the average mileage per locomotive per day by the average net train load, and that amount by the average rate per ton. Multiplying this sum by the operating ratio for the railroad will give the total operating cost of earning the revenue, and

the difference between the revenue and the expense will show the net earnings per locomotive per day.

The net earnings of a railroad go to pay taxes, interest on bonds, dividends on stocks and provide a surplus for investment in improvements. The first charge against earnings is taxes, the government and the state must have their share before other obligations are considered. If anything remains, interest must be paid, and after interest come improvements and dividends, with the payment of dividends to stockholders usually deferred in favor of the purchase of improved equipment and the construction of enlarged facilities.

The railroad man who wonders why the management does not give him better shops to work in, better locomotives and cars and improved facilities may find the answer by analyzing the performance of locomotives. If the engines are not earning a sufficient sum over and above expenses to take care of the taxes and interest, there is very little chance that new equipment will be purchased and improved facilities installed. But if the margin of earnings over expenses is sufficient, new engines and cars will be purchased and better shops and roundhouses will be built.

Very frequently it is necessary for a bankrupt railroad to have improved track and yards and new locomotives and cars before it can hope to operate on an income earning basis, and when such is the case the bondholders and the stockholders must go down into their pockets and supply the needed funds or else lose their equity in the railroad.

Locomotives when rented by one line to another, are paid for at the rate of \$50 a day upward, with the borrowing company making all necessary repairs, and it is only possible to rent power at all when some railroad has a surplus of power in good condition which it cannot put to any profitable use on its own lines.

A locomotive costing \$50,000, which is a low price for modern power, costs the railroad not less than \$6,000 a year whether it turns a wheel or not. This charge is made up of interest on the investment, insurance, taxes and depreciation, and is

the mere cost of ownership which cannot be reduced no matter how much or how little service the locomotive gives. As soon as the engine goes into service, expenses against it begin to pile up in the form of handling charges and repair expense, and it is only by making the locomotive work for a fair proportion of the time that it becomes a profitable investment.

187. Measures of Locomotive Efficiency.

The efficiency of locomotive performance is measured by the record made in a number of items:

1st. The work done per unit of power.

2nd. The cost of operation per unit of work done.

3rd. The cost of upkeep per unit of work done.

4th. The quality of performance.

The work done by the power on a division or a railroad, or by a certain class of power, or by an individual locomotive, is measured by the miles run and the tons of freight or number of passenger cars handled.

The record of performance in mileage per engine varies widely with the railroad and even with different divisions on the same railroad. There is also a very great difference in the mileage made by different classes of power on the same division and in the same class of service. It is obviously impossible to set up any standard of locomotive mileage which would fit all classes of power and all conditions of service. The powerful Mallet, hauling 500-ton trains at slow speeds, cannot be expected to make the number of miles per day traveled by the Prairie type engine handling 1500-ton trains in fast freight service. The oil-burning passenger engine, doubling over two or more divisions, as is the practice on many Western lines, will make more miles in a month than a heavy freight locomotive can make in four.

Standards of mileage per day or per year must, therefore, be set for locomotives of similar design and capacity operating under similar conditions. When any one talks about one hundred miles a day as a desirable standard to be striven for by all railroads, as an average for all classes of engines and all kinds

of service, they are setting up a measure which is about as practical and as valuable as a woman's tape measure would be for fitting frame bolts.

The mileage which an engine should make is governed by the design of the engine, by the class of service in which it is employed, by the load it is expected to haul, and by the conditions under which it operates. Heavy freight power in drag service may do well to average seventy-five miles a day throughout the year, when it is considered that a number of days must be spent in the shop undergoing repairs. Well designed medium sized freight power in fast freight service may average one hundred and fifty miles a day, while passenger engines frequently make better than three hundred miles a day as an average throughout the year.

The important factors influencing mileage are, the speed of trains over the division, the time required for handling and for running repairs, and the time consumed in making shop repairs or in waiting for shop room. Mechanical officials have no direct control over the scheduling of trains, but the quality of the work done in shops and roundhouses may have a very large effect upon how well schedules are maintained. An engine failure on the line frequently delays a number of trains and keeps units of power on the road when they should be in the roundhouse. The leaking or poor steaming engine not only spends excessive time between terminals but slows the movement of traffic all over the division.

The unnecessarily slow movement of traffic is not infrequently due to the overloading of the locomotives by the transportation department officials or to insistence upon engines starting out of terminal with their full rated tonnage regardless of their condition. Every engine should of course be in one hundred per cent condition when it leaves the roundhouse, but such a condition is ideal rather than practical. It is eminently desirable to put every ton of freight behind a locomotive which it will handle with reasonable assurance of making the schedule and keeping out of the way of other traffic, but there is nothing to be gained and much to be lost by loading an engine to the extent which

makes it necessary to spend long hours on the road and on side tracks waiting for the higher class trains to get out of the way.

The efficient transportation man is usually a tonnage fiend, because he has been taught that the more tons per train the less the cost per ton, and his enthusiasm for heavy loads should be balanced by the mechanical man's knowledge of the capacity of power, under average conditions, to make the required time with the maximum load.

It is only by the closest co-operation between the mechanical and transportation departments that a tonnage program can be carried out with the best possible results. The rating of a class of engines should be based upon what they may be expected to do day after day under average conditions and not upon what they may do when conditions are ideal, as otherwise what is gained in tons hauled will be lost in miles run. Ton miles, the basis of revenues, are based upon tons and miles, and not upon either independent of the other.

If it is necessary to run engines after their condition has become such that shop repairs are necessary, they should be given reduced tonnage, such as, in the judgment of the master mechanic, they are able to handle over the road without undue danger of failure or delay. The mechanical officer is not doing his full duty unless he keeps close track of the road performance of his engines and unless he gives the transportation department the benefit of his best advice as to the proper means of getting power over the road with the maximum tonnage and in reasonable time.

The time required to handle engines at terminals is a matter which is entirely in the hands of the mechanical executives and it is one of the points where the foreman can exert effort of most value to the organization. The subject of handling and repairing power will be gone into more fully in a following chapter, but certain points should be called to attention while considering the matter of locomotive performance.

The time required to handle power is, of course, largely influenced by the quality of the facilities provided, but the good roundhouse foreman will often make a better record with poor

facilities than the poor foreman can make with the best which money can buy. There is no matter in which the roundhouse foreman and master mechanic have a better opportunity to show the quality of their head work than in getting the engines into and out of the terminal in the shortest possible time. On many railroads the proportion of the total time spent by the power in roundhouses, or in roundhouse yards, is out of all proportion to the time spent in revenue earning service.

The railroad which has a thousand locomotives averaging only eight hours a day in service, could handle 25% more business with no further investment in power if the time of handling and repairing could be so reduced as to make the engines available for service ten hours a day. On the other hand, if a 25% increase in business was to be handled with no increase in the service time of locomotives an extra assignment of two hundred and fifty engines would be required. If the ownership charges on these engines averaged \$6,000 a year, the added expense to handle the business, in interest, taxes and depreciation alone, would amount to \$1,500,000 a year. A similar sum spent on improved facilities would mean a speeding up of handling and repair operations which would make the purchase of new power unnecessary, and such facilities once provided would mean reduced costs and lowered handling time for all the years to come.

The mechanical officer is not usually empowered to spend any large sums of money for improvements in shop equipment and facilities, but he fails in his full duty to his railroad and to himself when he does not call the higher official's attention to the fact that a comparatively small investment in improvements may frequently make unnecessary a large investment in additional equipment.

The roundhouse foreman can materially expedite the movement of engines through the house, regardless of facilities, by careful planning of every day's work, so that not an unnecessary moment is lost in the handling or repairing operations. By speeding up handling the foreman not only improves locomotive performance, but he lightens his own burden by providing more

time for the completion of repairs, thereby insuring better quality and more thoroughness, which will show up in the engine failure record and in the road performance of the power.

The time required on most railroads to make shop repairs is excessive. It has been frequently demonstrated that a modern engine can be given a general overhauling in less than a week, yet the average time which engines spend in the shop undergoing repairs is nearer a month and on many roads runs as high as two months or more.

The reasons for shop delays are numerous and many of them are more or less valid, although careful planning and close co-operation between the shop and the store department will eliminate many of them. When the higher management calls for a reduction of expenses, or places the shops on a monthly allotment, the mechanical officer can do nothing but protest and make the best of the force which is left to him. It is frequently true that the officers in the higher positions do not realize what an arbitrary cut in shop forces means in delayed repairs, in excessive costs, and in the demoralization of the organization, and they will never know unless the mechanical officers take the trouble to show them.

A protest, couched in general terms, against the reduction of force or the curtailment of allotment, will have little if any effect upon the general officers, who see the necessity for reducing expenses to hold outgo within income. The president or vice president is used to dealing in definite figures and a mere statement of opinion bears little weight with him. The mechanical officer who hopes to improve the efficiency of his department by persuading the general offices to allow him to spend money in order to save money must talk in the language of dollars and cents. He must present his argument in statistical form, and show his conclusions so definitely and conclusively that even a hard-hearted comptroller, who deals in debit and credit balances, will be moved to listen to reason.

The logical procedure is to plan the mechanical work for a year or more in advance, so that there will be no violent fluctuations in the demands upon the shops. This would be a compara-

tively simple matter if traffic were regular throughout the year, or if the variations in business could be accurately forecast. While it is, of course, not possible to determine accurately what business conditions will be a year or even three months ahead, certain general conclusions can be reached as to the possible increase or decrease in traffic volume and estimates made on the best available data should not be far out of the way.

The practice of the railroads, since the beginning of their history, has been to increase expense as increasing business made it necessary and to decrease when revenues fell off and any departure from this habit must come from an aggressive campaign on the part of maintenance men, both track and equipment, to correct the condition. Every mechanical officer knows the evil effects of fluctuating shop forces. He appreciates that when men are laid off the best of them will not remain idle to wait for their old jobs, and that when business improves he must hire new men and waste much energy and money in training them into proficient workmen.

Studies have frequently been made in factories to determine the cost of educating new men and the amount runs from hundreds of dollars for the common laborer to thousands of dollars for the highly skilled mechanics. All of the expense of breaking in new men and all of the inefficiency due to their employment might be saved if the work of the shop were planned for continuous operation throughout the year with the possible addition of an hour a day in times of heavy demand for repaired power.

There is very little excuse for engines waiting in shop for delayed material, although this is, perhaps, the most common cause of excessive shop detention. The mechanical officers should know approximately what material will be required to overhaul a locomotive weeks before it is taken out of service, and if the material is not ordered and delivered on time some officer of the mechanical, stores or purchasing department is responsible. Again it is planning which will prevent shop delays due to material shortage and it is the business of the mechanical man to see that the plan is made in such comprehensive and

accurate form that the store department will have no excuse for not following it.

The store department is not always to blame for material shortages, by any means. The purchasing agent and the storekeeper are charged with the duty of keeping down the investment in materials and supplies to the lowest possible figure and they cannot order indiscriminately everything for which the other departments may call. A splendid example of what may occur when the store department officials do not closely follow up the orders placed by the mechanical department to see that the material is actually needed, happened some years ago on a railroad where the management had paid little attention to details. This railroad had a single engine of a certain class which had been transferred around from one division to another a number of times in the course of several years. A check-up of material disclosed that there were seven sets of cylinders, at various division stores, which had been ordered by the mechanical department and purchased by the store department for this engine. The engine was old and inefficient and was finally retired while the fourteen cylinders, representing a cost of more than ten thousand dollars, were scrapped.

The problem of engines awaiting shop is one which should be taken care of by careful planning, so that roundhouse and shop repairs are co-ordinated in such a manner as to keep the engines away from the shops until such time as there is pit room for them.

CHAPTER XXXII

LOCOMOTIVE PERFORMANCE

(Continued)

188. Standards of Performance.

It is not only desirable but necessary to establish standards at which to aim. But, in order to be of the greatest value, such standards as are set should be attainable. The impossible standard, based upon ideal conditions and upon theoretical calculations, is of no use whatever and may be worse than useless in that it tends to discourage effort through absence of any hope of its attainment.

A standard of locomotive performance, in the matter of mileage, should be set for each class of power in regular service. Such standards should take into consideration all conditions of operation, and while they should always be higher than the past average record, they should not be based upon the best engine of the class, but rather upon the record of performance made by the best 20 or 25 per cent of the engines in the class. The mechanical man, whether he occupy the position of master mechanic, shop foreman or roundhouse foreman, should take a very active interest in the mileage record of the engines on his division, for the very simple reason that his own ability as an executive will be judged by the performance which these locomotives render. When there is a position open any place along the mechanical line it will go to the man who has shown the greatest ability to get work out of the power.

In freight service, the performance of the locomotive is measured not only by the mileage made but by the tons hauled, or to combine the two factors, by the ton miles manufactured. The best engine is the one which will haul the greatest number of tons the longest distance, taking into consideration, of

course, the cost of operation and maintenance. The passenger engine's performance is measured by its mileage, the weight of the trains handled, and by its ability to make the schedule.

All of the progressive railroads keep accurate records of locomotive performance, and these records should be, if they are not, furnished to each foreman on the division so that he may be fully informed as to just what the power is doing in service. On most railroads the record of fuel performance by individual locomotives gives most of the information necessary to follow up mileage and tonnage performance. The foreman who is ambitious to make a record by improving the performance of the locomotives under his charge should follow these mileage and tonnage records closely, not only as to the totals and averages showing the performance of each class of power, but as to the performance of each individual engine. By checking up each engine and analyzing the causes which prevent some units from coming up to the average of the class, the foreman should be able to discover the reasons for poor performance, and when the reason is found, the application of the remedy is not usually a difficult matter. The simplest method of improving performance as a whole is to keep after the locomotives which fail to come up to the average.

189. Cost of Operation.

The features of cost of operating locomotives in which the mechanical department is especially interested, and over which it has some control are, fuel consumption, handling cost, and cost of small tool supplies and lubricants. The fuel performance of a locomotive depends partly upon the manner in which it is handled by the engineer and fireman, partly upon its condition, particularly as to firebox and boiler, and partly upon the method of handling at roundhouses. There is a great difference between engineers and between firemen in their ability to get work out of an engine with the minimum consumption of fuel. With the same engine and the same train one engine crew will use 20 per cent more fuel over a division than will another. Where the organization is such that the mechanical officials supervise

the performance of the engines while in service, it is their business to improve the performance of the poorer crews by instructing them in the best methods of running and firing the locomotive in order to get the maximum amount of work out of the minimum amount of fuel.

Aside, however, from the effect of the ability of the engineer and fireman on the fuel performance of locomotives, there are a number of other factors, strictly within the control of the mechanical department, which make for good or bad performance in the matter of fuel consumption. On every railroad certain engines are known as "good steamers" or "poor steamers," and different engines of the same class, operated by the same crew, may show a wide variation in the amount of fuel consumed in doing a given amount of work. As all engines of the same class are of identical design and construction, there is no good reason why this condition should exist, and it is the business of the mechanical executive to see that it does not.

When locomotives are in assigned service it is sometimes very difficult to determine whether their fuel performance represents the ability of the crew or the condition of the engine, but when they are pooled it is a very easy matter to locate the engines which are unusually heavy fuel consumers. When an engine consistently uses more coal or oil than the average of its class in similar service, it is certain that there is something wrong with the drafting, or grate or ash pan arrangement, or that an excessive amount of scale has accumulated on the sheets, and flues.

The working out of the proper drafting arrangement for any class of power is not a complicated mechanical problem, particularly if the foreman will follow closely the performance of the various locomotives so that he may adjust the poor engines up to the standard of the good ones. The same thing applies to ash pan openings and to grate arrangement, and it is in the close supervision of all of these matters that the mechanical officer can improve the record of performance of his locomotives.

The effect of the presence of scale on sheets and flues is perhaps not fully realized by many mechanical men, and in order

to impress this point the following article on "The Relation Between Boiler Scale and Train Speed," by Mr. P. M. LaBach, Engineer Water Service, Chicago, Rock Island & Pacific, which appeared in a recent issue of the *Railway Age*, is quoted:

"A number of tests have been made which show that the scale accumulating on tubes and sheets of locomotive boilers when water is evaporated prevents a portion of the heat generated by the fire from reaching the water and consequently cuts down the number of pounds of steam that can be obtained from a pound of coal.

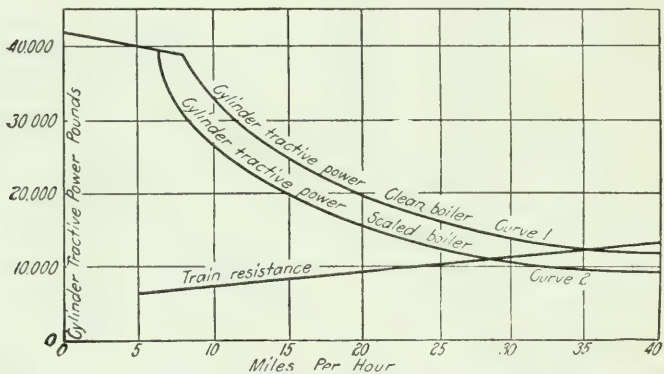


Chart to Show the Effect of Boiler Scale on Train Speed.

"That the effect of this upon locomotive operation may be pronounced can be gathered from the accompanying chart, which is useful particularly in showing the reduction that takes place in the speed of the train. The chart is prepared in the following manner:

"It has been demonstrated that the number of pounds of coal which can be burned on each square foot of a definite grate area for efficient combustion has a maximum which does not vary except with the temperature of the air. Where stokers are not used the factor is also governed by the number of pounds of coal the fireman can shovel per hour. These two factors being known from tests, the cylinder tractive force for an engine in perfect condition can be determined for all speeds.

"Curve No. 1 on the chart gives the values for an ordinary Consolidation, superheater engine of 42,000 pounds tractive effort. Curves of this type are in general use by motive power officers. To show the method of its use, if it is desired to know how much tractive force the engine has at 35 miles per hour, a line is extended from the 35 mile point on the horizontal scale upward until it intersects the curve, after which a line is drawn from that point on the curve horizontally to the vertical scale when the tractive force is found to be 12,200 lb., or less than half that of the starting power.

"Since, as was said at the outset, the effect of scale is to reduce the amount of heat generated for each pound of coal, it is obvious that if the same rate of combustion is obtained in the firebox the force curve will be materially changed by the presence of the scale in the boiler. It is not uncommon in bad water districts for flues to be covered with $\frac{1}{8}$ inch of hard scale. According to the tests made by the University of Illinois, the effect of such scale is to reduce the tractive power 20 per cent.

"The third line on the chart is the curve of train resistance, which in this case gives the tractive force required to overcome train resistance at different speeds on level track. All that is needed to produce this curve is the angle which the curve makes with the horizontal at a given speed.

"Let it now be assumed that a locomotive with clean boilers is given a load which it can haul at 35 miles an hour on a level grade and that it is desired to determine what the effect would be if the flues carried $\frac{1}{8}$ inch of hard scale. This is readily ascertained from the chart by following the train resistance curve until it intersects curve 2, which shows a speed of 28.6 miles an hour. The scaling of the boiler thus cuts the maximum speed of the locomotive from 35 miles an hour to 28.6 miles an hour.

"In actual practice, when the boiler is scaled up the attempt is often made to maintain the same speed as before. To accomplish this more coal is fired per square foot of grate area, if possible, but with the result that the increase in speed is not proportional to the increase in firing. For instance, an increased rate of firing of 25% might only increase the speed 20%. More-

over, in the case of hand-firing, the fireman himself is usually the limiting factor. If he did his best at 35 miles an hour in the first case given, the locomotive will only make 28.6 miles per hour unless the tonnage is cut down. Thus, in any event a loss is suffered by the presence of scale, since the scaled boiler simply means a smaller engine or less horsepower than a clean boiler."

From Mr. LaBach's analysis of the effect of scale upon the efficiency of the locomotive, the importance of keeping boilers clean, as a measure of fuel economy and as a means of helping the engineer to get over the road with full tonnage and in schedule time, will be fully appreciated. The cost of properly washing a boiler is not very great while the loss of revenue due to the necessity of setting out a hundred tons in order to make the schedule, or of slowing up the movement of the train in order to handle the tonnage, will run into hundreds of dollars on a single trip.

The cost of handling engines must be viewed from two different standpoints. It is desirable, of course, to hold down the cost of handling to the lowest possible figure, but nothing should be sacrificed in the way of speed and thoroughness in order to make a record for low cost. The first consideration should be the quality of the work done. There is nothing to be gained by neglecting proper attention to boiler washing and flue cleaning or any of the other handling operations. The practice of taking out two or three washout plugs and running a few gallons of water through a boiler in lieu of a thorough washout in order to save a little time and labor in handling is not economy.

Next to the quality of the work, consideration should be given to the reduction of the time required for handling, and this is particularly true when the capacity of the division to move traffic is limited by the amount of motive power available for service. Even when power is plentiful it is more economical to tie up the surplus power and run the engines in service at their full capacity than it is to keep the full assignment in service. When business is heavy, every additional locomotive hour which can be gained by reducing the time required for handling and repairs means increased earnings, and the cost of

expediting the movement through the roundhouse is a small item as compared with the service value of the engine.

The fact that the quality of the work is important, and that the speed with which it is accomplished is almost equally so, does not excuse the mechanical official from neglect of the cost item. It is not always the things which cost the most which are the most valuable. The adequacy of facilities, to be sure, have a large bearing upon the cost and speed of handling power, but the quality of supervision has an even greater effect. It is obvious that mechanical cinder handling devices, hot water boiler washing systems, and other modern facilities should reduce the cost and speed up the handling of engines, but the mere provision of such equipment is no assurance of better performance. There is no advantage gained by crowding an engine across the cinder pit and the turntable only to have it wait in the roundhouse for hours before the handling and repair operations are started.

The expeditious handling of engines is not nearly so much a matter of facilities as it is of competent planning so that forces are properly balanced and so that the various operations are performed in the proper sequence and without delay.

190. Cost of Upkeep.

A very important factor of locomotive performance is the cost of repairs. Years ago the accepted unit of measurement in this item was the cost of repairs per locomotive mile, but such a standard can no longer be employed. It is apparent that while ten cents per locomotive mile might have been a fair figure for maintaining Moguls and Consolidations, such a sum would be entirely inadequate for the upkeep of Santa Fe or Mallet type engines. There is no universal scale by which the proper cost of locomotive repairs may be set for all classes of power and for all kinds of service. The engine-mile unit breaks down entirely on account of the large variation in the size and power of different classes of locomotives; the ton-mile unit is of very little more value because it fails to take into consideration a number of important factors of operation. Every railroad

should have a set of standards by which the cost of repairs to its power can be measured, but such standards should be applied only to engines of similar type in similar service.

The cost of repairs on most railroads is divided in the accounts between running and classified repairs and a study of these figures is often illuminating as well as interesting. Some railroads believe in running their power hard with the minimum amount of running repairs, depending upon frequent shoppings to keep them in condition, while other lines make every effort to keep the locomotives in first class condition for as long a period as possible by giving them careful attention at the end of each trip, thereby lengthening the time between shoppings. As a general proposition it may be said that the latter procedure is productive of the best results, both in the performance of the power and the cost of repairs on a basis of the work done.

191. The Quality of Performance.

The quality of the performance of locomotives is measured by their ability to get over the road with their allotted load, without failures or delays. When tonnage must be reduced on a division on account of the condition of the power it is a black mark against the mechanical department, and the number of engine failures is a direct indication of the efficiency of mechanical supervision.

The importance of getting trains over the road without delay is well shown by a report of a committee of the Signal Section, A. R. A., which was presented at the convention held in Chicago in March, 1924. This report is quoted in part below in order that the basis of figuring the cost of delays may be understood, and the importance of their elimination may be appreciated. While this report was made primarily with the purpose of showing the savings which would result from the reduction of train delays by the introduction of automatic block signals, it serves equally well to indicate the economy which would result from the elimination of engine failures and general speeding up of movement which are incident to the improved condition of power.

"In beginning its study the committee divided the total operating expenses for freight train service on Class I roads during 1922, by the freight train hours, which gave an approximate cost of \$64 per freight train hour. The committee recognized that this figure included many items which would not be directly affected by a reduction of train delay; therefore in order to establish some basis on which the savings produced by the elimination of delays could be figured, a start was made by including only such items as are directly affected by a reduction in train delay.

"As a result only six items, i. e., locomotive repairs, engine-house expenses, fuel and other supplies, and the wages of enginemen and trainmen, are considered by the committee in its calculations as being affected by a reduction in the road hours of freight trains. The average unit costs of these items per freight train mile for the Class I roads, as set forth in the report of the Bureau of Statistics of the Interstate Commerce Commission for 1922, are inserted in column (c) in Table I as a basis for the calculation, the I. C. C. account numbers being shown after each item in the table. (See a following page.) In 1922 the average freight train load on the Class I roads was 1,466 gross tons or 677 net tons with 38.5 cars. The average train speed was 11.1 miles per hour.

"The problem confronting the committee was to use the I. C. C. unit costs per freight train mile as a basis for the computation of the costs per freight train hour. In Table I, column (c) lists these costs for each of the selected items per train mile. To determine the cost per freight train hour at a speed of 11.1 miles per hour, each item in column (c) was multiplied by 11.1 miles per hour entered in column (d). At a speed of 11.1 miles per hour, the trip of 125 miles is covered in 11.25 hours. Therefore by multiplying the value in column (d) (cost per freight train hour) by 11.25 hours, the product (cost per trip of 125 train miles) is secured and entered in column (e). The total cost of the six items selected gives \$1.735 per freight train mile, \$19.25 per freight train hour, and \$216.59 per freight train run of 125 miles at 11.1 miles per hour.

"Since the costs shown in columns (c), (d), and (e) are based on a speed of 11.1 miles per hour, the committee undertook to establish similar unit costs on the basis of an increased average speed of 12.5 miles per hour. It would seem evident that there should be a reduction in the cost of locomotive repairs on account of a reduction in road delays and the number of train stops. However, to be conservative, the committee considered the cost of locomotive repairs to be the same for both speeds and used the same figure, \$53.08, in column (h) as in column (e). Enginehouse expense was likewise considered as not affected by the speed of train movement, and the cost \$12.58, was fixed as the same in column (h) as in column (e). The remaining items are, however, affected by a reduction in road time and will be considered in detail.

"It should be kept in mind that the total train hours are to be reduced from 11.25 to 10 hours while the terminal time for enginemen and firemen will remain at one hour, therefore the total crew hours for these men will be reduced from 12.25 hours to 11 hours. This at once reduces the overtime from 2.25 to 1 hour which, when figured at time and one-half, gives 13.38 total payroll crew hours for a speed of 11.1 miles per hour as compared with 11.50 payroll hours for the speed of 12.5 miles per hour. This represents a saving of 1.88 hours or 14 per cent, as explained in detail in Table II. Therefore the cost of \$31.85 for enginemen's wages for the 125 train miles in 11.25 hours as listed in column (e) is reduced 14 per cent or to \$27.31, which amount is entered in column (h) as the cost of enginemen's wages for the 125 miles in 10 hours.

"Consideration of the savings to be effected in trainmen's wages shows that if 1.25 hours of road delay are eliminated, the saving in the overtime equivalent would be 1.88 hours and the total payroll hours would be reduced from 12.63 to 10.75 hours, a reduction of 14.88 per cent as shown in Table III. Therefore the cost, \$36.66, for trainmen's wages for 125 train miles at 11.1 miles per hour in column (e) is reduced 14.88 per cent and listed as \$31.21 in column (h) as the cost of trainmen's wages for 125 train miles in ten hours.

"It is considered that the locomotive is burning fuel for 3 hours' terminal time, which, added to the running time of 11.25 hours at 11.1 miles per hour equals 14.25 total locomotive fuel burning hours, while at a speed of 12.5 per hour only 10 train hours are spent on the road or a total of 13 fuel burning hours, a reduction of 8.77 per cent, as shown in Table IV. Therefore the cost of fuel for 125 train miles at a speed of 11.1 miles per hour, \$69.59 in column (e), is reduced by 8.77 per cent or to \$63.46, which figure is entered in column (h). The item headed 'Other Supplies,' which includes lubricants, was also considered to be reduced in the same ratio.

"The costs per freight train mile at 12.5 miles per hour, as shown in column (f), are determined by dividing the corresponding value of each item in column (h) (the cost of 125 train miles in 10 hours), by 125 miles. The costs per train hour at 12.5 miles per hour, as shown in column (g), are arrived at by dividing the values in column (h) (the cost of 125 train miles in 10 hours), by 10, the number of train hours in the run.

"In addition to the six items included in the calculations as explained above, the committee proceeds to include a seventh item, car repairs. The cost of \$0.73, listed in column (c) of Table I, is the I. C. C. unit cost for car repairs per freight train mile for Class I roads during 1922. For 125 train miles (in 11:25 hours) this amounts to \$91.16 for car repairs. A reduction in the number of train stops and starts would reduce the wear and tear on equipment and thereby reduce the cost of repairs. The committee states that it is the opinion of competent authorities that it is fair to assume that the elimination of the majority of train stops will save 10 per cent of the car repairs. Therefore reducing the item \$91.16 by 10 per cent, the figure \$82.04 is listed in column (h) as the cost of car repairs for 125 train miles in 10 hours.

"Continuing the calculations to include the car repairs, as shown in Table I, the total cost of 125 train miles at a speed of 11.1 miles per hour, \$216.59, is increased to \$307.75, while the total cost of 125 train miles at a speed of 12.5 miles per

hour, \$199.37, is increased to \$281.41. The difference between \$307.75 and \$281.41 is \$26.34, the saving effected by reducing freight train road delays 1.25 hours on a 125 mile trip, which is at the rate of \$21.07 per hour. The savings produced by eliminating the 1.25 hours delay on 20 trains per day at \$21.07 an hour would amount to \$526.75 a day or \$192,264 a year."

These calculations as to the cost of delays to freight trains are based upon a careful study of the question by men who are thoroughly competent to give an opinion and the figures which they arrive at may be taken as a conservative estimate of what delayed movements cost the railroads. It is not entirely the presence or absence of automatic block control which governs the movement of trains over the road. An engine failure is almost if not quite as costly on a railroad fully equipped with block signals as on one which has none, and delays to trains through poor condition of power are no less important in one case than in the other.

TABLE I

SAVINGS IN SELECTED EXPENSE ACCOUNTS, UNIT COSTS, BY REDUCING FREIGHT TRAIN ROAD DELAY $1\frac{1}{4}$ HOURS ON A ROAD TRIP OF 125 MILES

Selected accounts and account numbers		At 11.1 miles per hour, cost per			At 12.5 miles per hour, cost per		
		Freig't train, mile	Freight train, hour	125 M. in 11.25	Freig't train, mile	Freight train, hour	125 M. in 10 hrs.
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Locomotive repairs ...	(308, 311)	\$0.425	\$ 4.718	\$ 53.08	\$0.425	\$ 5.308	\$ 53.08
Enginehouse expense ..	(400)	.101	1.118	12.58	.101	1.258	12.58
Enginemen..	(392, 393)	.255	2.831	31.85	.218	2.731	27.31
Trainmen ..	(401)	.294	3.259	36.66	.249	3.121	31.21
Fuel	(394, 395, 396)	.557	6.183	69.56	.508	6.346	63.46
Other sup- plies	(397, 398, 399)	.103	1.143	12.86	.094	1.173	11.73
Total		\$1.735	\$19.252	\$216.59	\$1.595	\$19.937	\$199.37
Car repairs..	(314)	.730	8.103	91.16	.656	8.204	82.04
Total includ- ing car re- pairs		\$2.465	\$27.355	\$307.75	\$2.251	\$28.141	\$281.41

TABLE II
CREW HOURS FOR ENGINEERS AND FIREMEN

Items	Average speeds	
	11.1 m.p.h. Hours	12.5 m.p.h. Hours
Train hours (terminal to terminal).....	11.25	10.00
Terminal hours	1.00	1.00
Total crew hours (actual).....	12.25	11.00
Less basic day.....	10.00	10.00
Overtime hours (actual).....	2.25	1.00
Plus one-half	1.13	.50
Overtime payroll hours.....	3.38	1.50
Plus basic day.....	10.00	10.00
Total payroll crew hours.....	13.38	11.50
Time saved .....	....	1.88
Per cent .....	....	14

TABLE III
CREW HOURS FOR TRAINMEN

Items	Average speeds	
	11.1 m.p.h. Hours	15.5 m.p.h. Hours
Train hours (terminal to terminal).....	11.25	10.00
Terminal hours .....	.50	.50
Total crew hours (actual).....	11.75	10.50
Less basic day.....	10.00	10.00
Overtime hours	1.75	.50
Plus one-half .....	.88	.25
Overtime payroll hours.....	2.63	.75
Plus basic day.....	10.00	10.00
Total payroll crew hours.....	12.63	10.75
Time saved .....	....	1.88
Per cent .....	....	14.88

TABLE IV
FUEL BURNING HOURS

Items	Average speeds	
	11.1 m.p.h. Hours	12.5 m.p.h. Hours
Train hours	11.25	10.00
Terminal hours	3.00	3.00
Total fuel burning hours.....	14.25	13.00
Time saved .....	....	1.25
Per cent .....	....	8.77

CHAPTER XXXIII

FUEL ECONOMY

192. The Cost of Steam.

During the year 1923 the Class I railroads paid out approximately 530 million dollars for coal and oil to generate steam in locomotive boilers. This sum represents about 23% of the total cost of operating trains as represented in the charges to the transportation accounts. Carrying the figures farther it is found that out of every dollar earned by the railroads more than eight and one-half cents was spent for locomotive fuel.

These statistics will give the student some idea of the importance of promoting fuel economy by every possible means. The conservation of fuel has been the subject of discussion for many years, all of the railroads have made some progress along this line, and a few roads have made astonishing records in the saving of money through economies introduced in the methods of purchasing, storing, handling and firing coal and oil.

193. Fuel Consumption and Train Load.

The governing factor in fuel consumption, as in the cost of train operation as a whole, is found in train tonnage. The more tons or passenger cars behind the locomotive, up to the limit of tractive power in relation to grades and other operating conditions, the better will be the record of cost of fuel per unit of work performed. The first step, then, in a campaign for the conservation of fuel should be the proper loading of trains, so that each locomotive starts over the division with every ton of load which it can drag over the road in schedule time.

The loading of trains is not in the hands of the mechanical department, but its co-operation is essential if tonnage records are to be established, and every executive in the railroad service

should be interested in this important feature of efficient operation. But while tonnage is the largest single factor in determining fuel performance it is by no means the only one and the influence of the mechanical department in securing good performance is intimate and powerful.

194. Performance Records.

The first essential to improvement in any line is the determination of attainable standards and the establishment of records which will indicate currently and in detail the relation between actual performance and the possible records. Every up to date railroad, at the present time, accumulates and compiles accurate, current figures showing the fuel performance of each individual engine, and many roads carry the comparison farther and produce figures to show the performance of each engine crew, when engines are in pooled service.

Such records as these are invaluable in directing a campaign for fuel economy; in fact, results can not be obtained unless accurate figures are available to show the performance as to fuel consumption by engines and by enginemmen. With tonnage standards established at an efficient figure and competent records of performance, the conservation of fuel becomes a matter of constant attention to the details of purchasing, inspection at the mines, handling, storing and firing, and of the proper regulation of the various locomotive parts and appliances which have to do with the thermal efficiency of the engine.

Performance records are of no value whatever unless they are properly and constantly used to direct the efforts of enginemmen and mechanical officers in perfecting better methods of running and firing locomotives and in correcting mechanical conditions which contribute to waste.

195. Analyzing Performance Records.

Engines of identical design, in relatively the same condition and in the same service will show astonishingly wide difference in fuel performance. A competent analysis of performance

records brings these differences to light and suggests the measures which should be taken to bring the poor performers up to the standard of the good performers. There are, of course, a number of factors which may affect the fuel performance of a locomotive and the real trouble must be located by a process of elimination.

When locomotives are in pooled service it is a simple matter to distinguish between the performance of crews and engines. The best engine in the class, as to steaming qualities, will head the list because the performance of the crews will be equalized by rotation. Even when it so happens that the good crews get certain engines more frequently than they do others, it is possible to determine the performance of the locomotive by analyzing its performance by trips. When the good engine and the good crew get together, the best fuel records will be made; the average engine and the average crew will make the average record while the poor engine and the poor crew will always stand at the bottom of the list.

It is not a difficult matter to arrange the locomotives in the same service and of the same class in the proper order of their efficiency with regard to fuel consumption. The same thing may be done with the crews. After this analysis is made a fair basis is established upon which to make a study of the conditions which make one crew better performers than another and which permit one locomotive to handle a train with less fuel than does another of the same class.

196. Effecting Economy.

On many railroads "poor steaming" is given as the cause of engine failures or of an engine reducing tonnage in order to get over the division in reasonable time. There is no cause of failure which is less excusable or more expensive, for even though the engine does not actually get on the failure sheet, the cost of its operation is excessive. After the difficulty has been located either with the crew or the locomotive the matter of improving performance becomes a question of competent supervision. If the difficulty is with the crew, the remedy is to give the engineer and fireman special instruction, through

road foreman and traveling fireman, so that they may be informed as to the best methods of running and firing in order to secure the best results in fuel economy. If the trouble is with the engine, a thorough inspection of draft rigging, grate arrangement, ash pan openings, and the condition of the flues and firebox sheets, should locate the difficulty.

It is not to be expected that the performance of the best engineer and fireman on the division can be equaled as an average by all of the crews, but great progress can be made by consistent instruction of the men who show the poorest fuel performance, the constant effort being to bring the performance of the less efficient men up to the division average. By this means the division average is constantly improved, and while there will always be good engineers and poor engineers and good firemen and poor firemen on the division, the general average of performance will be consistently improved and the fuel bill of the railroad will be constantly decreased.

If the matter is properly handled, it is possible to interest the engine crews in their fuel performance to such an extent that the record of the division will show constant improvement. In order that this may be accomplished it is necessary that the officials of both the mechanical and transportation departments take an active interest in the records of fuel performance by crews, and that they talk to the men about their performance, complimenting those who make exceptionally good records and encouraging those who do not do so well.

Along this line it may be called to attention that the Pere Marquette Railroad has made a splendid record in fuel performance during recent years through this means of interesting the crews in their performance. To quote from the *Pere Marquette Magazine* for November, 1924: "It has been made a sporting proposition with the engineers and firemen." There is a certain amount of sporting blood in every worth-while man, and if it can be appealed to, records will fall and general performance will be greatly improved.

It must be understood, however, that the mere establishment of individual fuel performance records does not insure improve-

ment. Further, it is possible to create dissension and dissatisfaction among the engine men by improper or injudicious use of such information, and when such a condition exists the effect of the campaign is lost. In the first place, the figures of fuel consumption must be as near accurate as it is possible to make them; the charges to engines and to engine crews must be carefully recorded and checked before statements are prepared, so that the figures as published shall not be open to question through obvious inaccuracies. If the engine crews become properly interested in their fuel records they will keep their own record of the tons of coal or gallons of oil drawn at coal chutes or fuel stations, and unless the records of the fuel department are correct the enginemen will lose respect for them and will, perhaps, fail to make their best effort in the belief that they will not get proper credit for the performance made.

Another important matter, when the record of individual enginemen is under consideration, is to arrange the fuel records so that fuel used in terminals or enginehouses, when the engine is not in charge of the crew, shall not be charged against the performance of the men. While it is hardly practical to weigh or measure the coal which is used in firing up or in holding engines under steam awaiting a call, it is possible to set up a fairly accurate figure to represent the fuel so used and this amount should be deducted from the total consumption of the engine or the crew. If a proper and accurate report of engines held under steam at terminals is kept the amount of fuel so used may be calculated with very fair accuracy, and such a report is of great value in checking up delinquency in the roundhouse or in the dispatcher's office, with respect to the unnecessary detention of engines under steam.

197. The Roundhouse and Fuel Performance.

Accurate records of fuel performance by individual locomotives give the roundhouse foreman and the boiler foreman the essential information needed to bring up the standard of fuel performance for all of the engines on the division. When one engine of a class burns more fuel to perform a given amount of

work than do others in similar service, it is the business of the mechanical men to find the reason. It may be that the poor performer has a heavy coat of scale on her sheets which the boiler washers have failed to remove. It may be that the nozzle opening is not right or that the draft plates are not properly arranged. It is possible that the flues have not been properly cleaned, or that the ash pan openings are too large or too small. By comparing one engine with another, and noting the differences between the good steamer and the poor steamer it should not be very difficult to locate the difficulty and to bring the low engine up to the standard of its class.

On some railroads draft grate and ash pan arrangement are strictly standardized and no variation from this standard is permitted. On other roads, nozzle openings, ash pan arrangement and other details are left to the local management and to the engineer. The practice of standardization, theoretically at least, is the best practice, as it is logical to assume that two engines of identical design will give best results under similar conditions. The trouble with such standards is, that unless they are very carefully worked out, they may not represent the highest efficiency in practice, and results may be sacrificed to uniformity. Further, every mechanic knows that no two machines will perform exactly alike, although their design and construction may be as nearly similar as it is possible to make them. Experience would indicate that every locomotive should be treated as a separate unit and that a study should be made of its peculiarities so as to get from it the highest possible rate of efficiency.

198. Records of Consumption.

In the history of railroad operation there have been many remarkable records of fuel performance. On some roads a consistent campaign carried out for several years has reduced the consumption by as much as fifteen or twenty per cent. Twenty per cent of the 500 million dollars spent yearly by the Class 1 railroads would amount to the substantial sum of 100 million dollars, an amount which would furnish the purchase price of a large amount of new equipment.

While the fuel performance of one road with another, or even of one division with another on the same road, is not comparable unless a number of highly variable conditions are properly weighed, certain definite figures should be of interest. On the Missouri, Kansas & Texas, where fuel economy has been a management hobby for some years, very creditable results have been secured. Some of the figures of performance for this road, as given in the *Railway Age*, are quoted below:

"Fuel consumption on the Missouri, Kansas & Texas during July, 1924, was .9 of a gallon per car mile in passenger service and 9.6 gallons per 1,000 gross ton miles in freight service. A record has been kept of each division in each class of service showing the gallons consumed per passenger car mile and per 1,000 gross ton mile including all the fuel used in through and local passenger service, through and local freight, mixed trains, traveling switch and light engines running for the benefit of freight and consumption at all terminals.

The St. Louis coal-burning engines in passenger train service averaged 12.6 pounds per passenger car mile, equivalent to one gallon of oil per car mile. Coal-burning engines in freight service averaged 96 pounds of coal per 1,000 gross ton mile, equivalent to 7.6 gallons of oil.

"In passenger service the McAlester district ranked first among the districts with .8 gallons per car mile and 8.7 cars per mile. In freight service the McAlester district also ranked first, with 7.7 gallons per 1,000 gross ton miles and 2,276 average tons per train. In yard service the North Texas district ranked first, having used 9.4 gallons per engine mile.

"Among the unusually economical consumptions during August, an engine on an excursion from Waco, Texas, to Galveston with twelve cars consumed 2,025 gallons of oil in making 3,456 passenger car miles or .58 of a gallon per car mile. Another engine in June burned 7,509 gallons of oil, making 9,124 car miles or .8 of a gallon per car mile. In July the same fireman used 5,813 gallons making 6,751 car miles or .8 of a gallon per car mile, and in yard service in August he used 8.3 gallons per engine mile.

"On August 23rd a crew handled 1,802 tons from Smithville, Texas, to New Ulm, 3,408 tons from New Ulm to Houston, a total of 70 miles, or 319,560 gross ton miles, on 1,256 gallons of oil, or four gallons per 1,000 gross ton miles. The run was made in 7 hours and 35 minutes, taking water twice, 16 inches of water being in the tank on arrival at Houston."

CHAPTER XXXIV

ASSIGNMENT OF POWER

199. Division Assignment.

The proper distribution of the available power to the various divisions and its assignment to service in such a manner as to contribute most effectively to train operation is one of the important problems of railroad administration. Practically all of the railroads own an assortment of power, ranging from the light standards of a quarter of a century ago to units of the most modern design. Some few railroads have been fortunate enough to be able to retire locomotives as they became obsolete, and to purchase engines of improved design and greater tractive power to replace them, but the majority of roads, while they may have a certain amount of up-to-date power, must continue to operate many units which are neither as heavy nor as efficient as they should be to perform the most effective service.

The problem of locomotive assignment is comparatively simple when the finances of the railroad permit constant purchase of equipment to keep pace with increasing traffic requirements and with the progress of mechanical design, but most railroads must continue to operate many units of power which belong to a past age. The problem of the most efficient assignment of the power available for service becomes increasingly difficult as the proportion of modern engines to the total number owned decreases.

In order to distribute a railroad's power to the best advantage, it is necessary to make a complete survey of operating conditions. The density of traffic, the ruling grades, the ratio of through and local business, the length of side and passing tracks and many other factors must be taken into consideration in determining what classes of power should be assigned to the

several divisions. The location and capacity of shop and round-house facilities may also have their influence on the problem. It is obviously inefficient to assign engines of large tractive power to a division where the passing tracks are not long enough to hold the trains which must be hauled in order to realize the benefits of their great power.

A very good rule to follow, on lines where the trackage facilities permit, is to assign the lighter power to the level divisions and the heavier units to the sections of line which have a heavier ruling grade, so that solid trains can be handled straight through from one end of the system to the other without breaking up at terminals. It was determined, in working up data for the rate cases a number of years ago, that it cost as much to handle a car through a terminal as it did to haul it one hundred and fifty miles over the line. This terminal movement is almost entirely non-revenue and every dollar which can be saved by eliminating unnecessary switching means one more dollar in the net revenue account.

Another very good rule in locomotive assignment is to keep the engines of a class together to as great an extent as is possible. A group of engines of a single class scattered over a number of divisions cannot be as efficiently operated or as economically maintained as the same engines running out of a single terminal. Every class of engine has its peculiarities, and both enginemen and mechanics must get thoroughly acquainted with the locomotives which they run and maintain before they can be expected to get the best possible results out of them. On a division with a mixed assignment, the problems of operation and maintenance are complicated by the lack of interchangeability.

200. Pooled Engines.

The pooling of engines on a division is relatively recent practice, and there are still many able authorities who contend that better all-around results will be obtained by assigning the locomotives to the several crews. The argument as to the merits of the two systems has been going on for years and it will probably never be settled to the satisfaction of every one. There is

much to be said on both sides, and so long as operating conditions vary widely on the several railroads it would take great courage to say positively that either one system or the other was the better under all circumstances.

The pooling system came into use with the limitation of hours which an engine crew might be required to work. Particularly with light power, which can be turned and repaired in a comparatively short time, the capacity of the engine for work is greater than the capacity of the men who run her. When business is heavy, therefore, power may be kept on the road a maximum number of hours a day by pooling the crews and letting each man in turn take the first available engine. Upon this theory the pooling system has merit over the assignment plan, but there are other factors which must be taken into consideration.

The factor of investment must also be considered in deciding which system of operation is best. There is no question but that a railroad can be operated with fewer engines under the pooling system than under the assignment system, provided only that the mechanical forces can turn the power faster than the crews can get their required rest. Under most conditions, then, the investment of the railroad in the power necessary to move the traffic will be less when engines are pooled than when they are assigned. This is sometimes a factor of great, even of the greatest, importance. The railroad which is not earning enough money to purchase all of the power which might be effectively used, must devise means of stretching such locomotives as it does own over the business which is offered for handling.

Pooling engines and doubling them over two or more train districts, as has become rather common practice in passenger service, is an effective means of getting more mileage per year out of every unit of power, and is the only effective measure which is available on many railroads. There is no question but that repair costs will be higher on pooled than on assigned engines, and that failures will be more frequent and fuel performance less efficient, but these disadvantages must be weighed

against the greater operating flexibility of the pooling system and the fact that less money need be invested in equipment.

The doubling of engines over two or more train districts has been very successfully tried out by a number of railroads, and under certain conditions the practice is certainly justified by results. The assigned passenger engine, running over a single division, does not spend very much of its time in actual service, and while it stands in the roundhouse it is earning nothing to apply against the interest, depreciation and insurance charges which are constantly accruing. While it is true that the locomotive so operated will not make the same mileage between shop-pings, and that the cost of repairs per train mile will be substantially higher than for the assigned locomotive running over a single division, its fuel performance may be better, on account of eliminating one or more fire-ups for each trip, and the ratio of the revenue it earns to the total of the operating expenses charged against it will be considerably higher.

201. Assigned Power.

The other side of the power assignment problem can best be presented by quoting a discussion given by Mr. E. Von Bergen, Air Brake and Lubrication Engineer of the Illinois Central, before the Traveling Engineers' Association:

"Last year at the traveling engineers' convention I listened to the paper on long locomotive runs and, as I recall it, everything said was in favor of running engines over several divisions. The paper extolled the merits of such a system of handling engines and set forth vast savings that could be and were being effected by this policy.

"After listening to the paper and the subsequent discussion, the natural conclusion which anyone would draw was that the quickest way for a railroad to make a lot of money and obtain much greater service from engines at lower cost would be to begin immediately running engines over several divisions. Before becoming converted to such a proposition, I decided to look into the performance of several railroads which have been widely advertised in the railroad publications as having accom-

plished great things by running engines over several divisions. I wanted to find out in just what respect their handling of power was superior to the method used by the Illinois Central. On this railroad locomotives are assigned to run only on each division; enginemen and firemen are assigned to regular engines; some passenger runs, termed 'blanket runs,' extend over two divisions, a total of 235 miles, but the engineman and fireman assigned to the locomotive run through with it. This has been the practice on the Illinois Central for many years. Through all the clamor and propaganda purporting to show the benefits of pooling engines, we have held steadfast to the policy of assigning engines to regular enginemen and firemen.

"The same argument that has always been advanced in favor of pooled engines is now advanced in favor of running them over several divisions, i. e., that railroads have a lot of money invested in locomotives; a locomotive makes money only when it is making miles; it earns nothing standing still. If this money invested in locomotives is to earn the greatest return the power must be kept moving. Therefore, it is poor policy to let it stand idle while crews are taking their rest, or in the present proposition, to let it stop at a terminal at all as long as it can be kept moving.

202. Value of Pooled Engines Questioned.

"The premises of this proposition are sound. I fully agree that engines earn a return on the investment only while they are moving, and that any comparisons drawn should be based on the average miles per engine per year, obtained by any railroad. But the conclusion that so many railroad men have reached, that pooled engines, or running engines over several divisions, is the way to obtain the greatest mileage, is entirely wrong, as I will prove by comparative figures.

"No doubt many have been misled on this proposition because the advocates of pooled engines, or long runs, in presenting locomotive mileage figures, have not taken into account the engines lying idle receiving repairs, or awaiting repairs. They lose sight entirely of the fact that any locomotive requires a

certain amount of maintenance, and this amount increases in proportion to the lack of interest taken in the machine by the engineer. Enginemen operating pooled locomotives take very little interest in them, while enginemen with regular engines look upon them the same as personal property. The increased maintenance required for pooled engines means more idle time.

"After all the smoke of arguments in favor of long runs has cleared away, such as reduced forces required to turn engines, fuel saved firing up, etc. (which is all theoretical, the reduction in force being an insignificant factor and the fuel saved firing up being offset by excess fuel used maintaining steam pressure with dirty fires), the only real object which remains for running engines over several divisions is to reduce the number of locomotives required on a railroad; in other words, increase the mileage obtained per engine, which means increased earnings on the investment in each locomotive. To find how this works out in practice, the only way to determine what is actually accomplished is to consider the total locomotive miles and total locomotives on any railroad in a given year, and then determine the average miles per locomotive per year. This comparison will disclose the actual accomplishments under various systems of handling power, whereas citing a few engines on a few runs determines nothing.

203. Locomotive Mileage High and Maintenance Cost Low.

"Upon drawing a comparison between the Illinois Central System, including the Yazoo & Mississippi Valley, operating assigned engines and several other railroads operating engines over several divisions, I found that during the years 1922 and 1923 the Illinois Central obtained more miles per engine, and at a lower maintenance cost, than any of them, as the figures in the table will show.

COMPARATIVE LOCOMOTIVE UTILIZATION AND
MAINTENANCE COST

1923

Railroad	Engines Owned	Locomotive Mileage	Average Per Eng.	Maint. Per Mile
Illinois Central	1,790	58,060,076	32,436	\$26.53
New York Central.....	3,440	90,599,869	26,337	29.64
Big Four	912	28,959,509	26,304	30.97
Union Pacific	1,026	30,948,254	30,164	30.62
Santa Fe	2,123	62,586,439	29,480	36.00
Frisco	976	27,078,813	22,744	37.05

1922

Illinois Central	1,746	52,768,806	30,222	\$23.60
New York Central.....	3,381	75,250,952	22,257	25.03
Big Four	926	22,398,060	24,188	25.21
Union Pacific	1,895	50,765,729	26,684	30.95
Santa Fe	2,142	57,674,351	26,925	32.16
Frisco	951	24,275,308	25,526	36.00

"This proves conclusively that the Illinois Central not only earned a greater return on its investment in locomotives but in addition saved a large sum on maintenance. During the year 1923, had the maintenance cost been as great as the lowest of the roads compared with, it would have cost the Illinois Central \$1,805,668.36 more to maintain its locomotives than it did cost.

"Had the maintenance cost been as great as the highest compared with, it would have cost \$6,107,919.99 more for the year 1923.

"The advocates of long locomotive runs assume that with such a system money will be invested in locomotives only to the extent that barely sufficient passenger and freight locomotives will be owned to handle the passenger and freight trains, thus reducing the investment required. This is impossible. In passenger service the number of trains on many roads fluctuates largely at different seasons of the year. There are also special trains or additional sections operated. Therefore, a sufficient number of locomotives must be owned to take care of these extra trains.

"Under a long-run, or pool system, a number of locomotives lie idle when only regular trains are operated, while the remainder are turned as rapidly as possible. Under the regular assigned system on the Illinois Central, when an emergency arises requiring the handling of an additional train, or trains, some regular engine is always available that can be used for a trip while the regular engine crew are laying over at their home terminal. Therefore, in reality, under a regular engine assignment system the total ownership of locomotives does not greatly exceed that with pooled engines under a long run system. It is merely a matter of keeping the greatest possible percentage of engines in service at all times, and the maintenance cost per locomotive mile on the Illinois Central compared with other roads proves this policy very economical.

204. Enginemen's Interest in Assigned Power.

"This economy is possible largely on account of the personal interest and pride of the engineers in their regular engines. It is practically equivalent to having a road foreman on every engine every trip. These enginemen insist on every defect, no matter how small, being corrected by the shop forces immediately as they develop, and the old proverb, 'A stitch in time saves nine,' applies to nothing more forcibly than to locomotive maintenance. A defect costing one dollar to repair today may cost twenty dollars or a hundred if neglected until the next trip. The personal interest in their regular engines, expressed in the words 'my engine,' is worth millions to the railroad. It follows that with repairs looked after so closely, when a locomotive is started from a terminal it is in condition to make a successful trip. I have personally operated engines under both the pool and regular engine plans, and I know from experience that under the pool system, enginemen take no interest in the engines and on this account it is customary to dispatch engines with minor defects existing that run up maintenance cost in the end.

"Years ago, just after the sixteen-hour law was enacted, we tried out on a division on which I was employed the same scheme that is now advocated for long locomotive runs. It

was a single track division 160 miles in length. The division officers felt it would be impossible to make this 160 miles with freight trains within 16 hours, so they established a district terminal at an intermediate point on the division as a relay point. A crew arriving there was relieved, and another crew took the same engine and train through. Within a short time the engines were in the worst condition I had ever seen them, and the total time consumed over the division with freight trains was usually 25 to 35 hours. On that division today the same class of freight trains cover the division in 8 to 12 hours. Twenty-six miles of double track are in operation, but the greatest single factor in this improved operation is that, all locomotives being in high-class condition, it is possible for train dispatchers to depend so thoroughly on their performance that accurate schedules and meeting points can be laid out.

205. Comparison of Fuel Consumption.

"On the Illinois Central we would effect no saving in fuel by running locomotives past our present terminals. To avoid long coal hauls and greatly increased prices, we must of necessity use a grade of coal that contains a high percentage of clinkering elements on the greater number of our locomotives. Under the present system, when passenger engines arrive at a terminal, seven or eight minutes are required on the ash pit to remove the clinkers and, where engines lie over only two or three hours, the fire is banked with a few shovels of coal. If crews were changed and the engines run through, the clinkers would increase so rapidly it would require far more coal to maintain steam pressure than is now used for banking the fire.

"If men were brought from the enginehouse to the passenger station, which in many cases is a mile or more from the enginehouse, to clean the fire, the cost of their time and of removing the dumped fire from the track would be greater in proportion to the length of time away from their duties at the shop.

"A certain amount of maintenance is required on each locomotive regardless of whether it runs over one division or six. Claims that have been advanced that the number of maintenance

men were reduced when locomotives ran through indicate only one of two things; either too many maintenance men were employed for the amount of work performed before the locomotives were run through, or maintenance was neglected after they were run through. The comparative maintenance costs shown indicate clearly that there is no economy in maintenance when running engines through.

206. Maintenance Standards.

"Locomotives on the Illinois Central are maintained at a high standard of efficiency. During the month of August, 1924, with an ownership of 1916 locomotives, of which 1816 were in service, making 4,305,261 locomotive miles, there were only twenty-nine engine failures in all classes of service, or 148,457 locomotive miles per engine failure. This covered failures of any kind that resulted in a passenger train arriving at a division terminal over five minutes late, or a freight train over twenty minutes late. The total train delay resulting from the twenty-nine failures amounted to 38 hours and 22 minutes. With over 12,000 driving journals in operation, there were no hot driving journal bearings during the entire months.

"The total hot bearings on locomotives occurring on the entire system during the month of August were as follows: Engine trucks, five; driving boxes, none; trailers, one; tender trucks, none.

"I believe this locomotive performance will compare favorably with any, and that it would be impossible to equal it if we were pooling engines and running them over several divisions. Running engines over several divisions means pooled engines; the so-called assignment of certain engines to certain long runs also means pooled engines. The same principles are involved where seven or eight men run four or five engines as where thirty or forty freight enginemen run fifteen or twenty freight engines in pool service. In the light of the facts I do not see how anyone can consistently say that the Illinois Central would benefit by pooling engines and running them over several divisions."

This discussion of Mr. Von Bergen's very ably presents the assignment side of the argument, but it should not be taken by the student as the final word on this important subject. In considering the figures which have been given, and which are interpreted to prove the point that assigned power running over a single division can be more economically operated than pooled power run over more than one division, it should be understood that the comparison is by no means conclusive. No figures are given as to the comparative size of the power on the various railroads under investigation, as to the tonnage hauled in freight service, the average number of cars per passenger train, or as to line gradients.

It is obviously unfair to compare the mileage made by locomotives, unless the loads they handle are given consideration at the same time. The cost of maintenance per locomotive mile as used in Mr. Von Bergen's statement, as is pointed out in another chapter, is a unit which has absolutely no value when it is considered that the average size and power of locomotives varies through a wide range, and that the amount of repairs required is influenced by many other factors besides the miles run.

The Illinois Central has a large number of very light engines used in suburban service, and its tonnage per freight train mile is not so high as that of several of the other railroads used for comparative purposes. It is therefore obvious that this question must be more exhaustively investigated before it can be said with certainty that assigned engines give greater efficiency and economy than pooled engines, when all factors are considered.

It should be said here that the standard of locomotive maintenance on the Illinois Central railroad is notably high, but whether the credit belongs entirely to the system of operating the power or whether a large share should not go to the quality of supervision in the mechanical department, is a question which should not be overlooked. It is well known that this railroad has very few broken frames, while some other railroads operating power of similar design have a great deal of trouble from this source. The reason that the Illinois Central has very few

broken frames is that the mechanical department has introduced the consistent practice of setting up the driving-box wedges at the end of each trip, and it seems very likely that the splendid engine failure record quoted, the general good condition of the power, and the low cost of repairs, are due in very large part to unusual efficiency in the shops and roundhouses, and it does not necessarily follow that if the engines were pooled, expenses would be higher or performance less efficient.

It is not the intention, in pointing out these weak points in the argument for assigned power, to influence the student to accept the pooling principle as the best practice under any and all conditions, but rather to impress upon him the fact that a complete analysis of the situation is necessary before a competent decision can be made.

The majority of the railroads, at the present time, use the pooled system to a greater or less extent, but this does not indicate that it is the best plan under all conditions. It is only possible to say that assignment or pooling is best for any particular railroad after a complete investigation and analysis has been made of the operating conditions on that property. A plan which may give excellent results on one road may be a total failure on another and there is no ready-made scheme of operation which will fit into all conditions any more than there is one suit of clothes which will fit both fat and lean.

207. The Other Side.

As some space has been given to a specific argument in favor of the assigned engine, and against the extension of runs over more than one division, it is only fair that the other side of the question be presented by a railroad man who sees great merit in the pooling system. After the student has read both sides of the question as presented by enthusiastic partisans, he should be able to form his own opinion as to which system seems best to fit the conditions which obtain on his own railroad.

The following quotations are from a paper presented before the Pacific Railway Club by Mr. Frank E. Russell, Mechanical Engineer of the Southern Pacific:

"We have heard and read more about long locomotive runs during very recent times than in past years, and as our ideas and thoughts are governed largely by comparisons, what would have been considered a long run two generations ago would be termed a very short run these days.

"Shortly after the first steam locomotive was actually put in operation some of the enthusiasts, in discussing and writing about the possibilities of the new machine, became so visionary as to predict that at some day in the future the machine might be so perfected as to travel at the unprecedented speed of a mile a minute. On the other hand, there were many wise men of that day and age who contended it would be impossible for a human being to live traveling at that rate of speed, and furthermore, claimed that it would be impossible to build a machine which could run faster than 12 to 15 miles per hour and hold up under the service.

"In order to appreciate the thought of the people at that time it must be remembered that their most rapid means of transportation was by saddlehorse. We have since advanced from the small crude locomotives first designed for railroad transportation to the huge modern locomotives of the present day. Paralleling this with other means of transportation, we have advanced from the one-horse shay to the luxurious automobile and aeroplane.

The development of the steam locomotive has kept pace with the development of civilization, for during a period of about a hundred years the steam locomotive has developed from a crude miniature machine, capable of little more than self-propulsion and running not over 15 miles, to a huge efficient machine capable of handling smoothly and easily luxurious passenger trains consisting of 12 cars weighing 875 tons over mountain, desert and plain at high speed for a distance of 815 miles. The existence of the locomotive corresponds to three generations and its development follows very closely the development of railroading which can also be divided into three characteristic periods, the period of railroad construction, the period of expansion and rule-of-thumb methods and the period of

improvement in materials used and application of mathematical talent in computing stresses and proportioning parts.

"The locomotives placed in service up to the year 1864 were of crude construction and wrought iron was the principal material used. They were not equipped with power brakes or any of the modern devices.

"During the next period, 1864 to 1894, the principal changes in locomotives in this country were generally an increase in size, application of air brakes, automatic couplers, injectors and other appliances and the use of steel in construction.

"During the period 1894 up to the present time we find new materials used and much improvement in design, also many new devices developed, not only increasing the power output and durability, but also producing more economy and higher efficiency. The most important of these devices are superheaters, feedwater heaters, brick arches, boosters, improved valve gears, and improvements in air brakes and lubricators, all of which have a marked effect upon the distance over which the locomotive can be successfully operated.

208. Conditions Determine Length of Runs.

"There are many conditions which determine how far a locomotive can be economically operated. The first and most important of these is the topography of the country which determines the gradient and curvature, making it necessary to change power to suit the grade conditions.

"The location of shop facilities is to a great extent controlled by the character of the country and operating conditions. In most cases these facilities were established many years ago when roads were built to suit the power and equipment then in use and there is no question but that a great many locomotive runs could be extended more or less if we could easily move the shop facilities to take care of the power. This, however, would mean an expenditure of huge sums of money which could be used to better advantage for other purposes.

"Under present-day conditions, where terminals and repair facilities have already been located, it requires considerable

courage on the part of the motive power and operating officers to extend locomotive runs, especially as they cannot readily increase the runs, say 10, 20 or 30 per cent, but must take a bold jump and double or treble the distance. Thus in referring to long locomotive runs, they are generally considered to be such only when locomotives are operated over two or more districts where the power formerly was changed. The mere fact that locomotives may be successfully operated over an unusually long distance may not necessarily mean the most economical operation. The most important object in extending the runs is to increase their productive time, or in other words, obtain greater monthly mileage from the power.

"The time locomotives are at terminals, in enginehouses, etc., is non-productive time. Taking the Class I railroads in the United States during 1921, the average non-productive time of freight locomotives amounted to somewhat more than 17 hours out of the twenty-four; hence the locomotives were idle and not earning two-thirds of the time. In fact, during this time they are not only non-productive, but are actually costing the railroads considerable sums of money for attention and fuel in keeping them hot and otherwise taking care of them at terminals.

"The average monthly mileage of freight locomotives in active service on all classes of railroads during the year 1921 was only about 2,400 miles, and for passenger locomotives only 4,100 miles. Hence it will be seen that there is an ample opportunity for improvement by obtaining greater mileage out of locomotives, which is equivalent to increasing the number of locomotives in service.

"Many railroads are cognizant of these advantages, as is revealed by the number of railroads increasing the length of locomotive runs. In the table on a following page several of the more striking examples of long runs in passenger and freight service have been listed, and show the remarkable progress that has been made in this phase of operation.

"Modern appliances such as the superheater, feedwater heater, brick arch, and booster have contributed to the possibility of running locomotives over greater distances than have heretofore

been considered feasible. The effect of the superheater is virtually to increase the boiler capacity. A locomotive equipped with superheater can perform approximately the same work and the boiler only evaporate two-thirds as much water as a saturated-steam locomotive. This in turn is equivalent to increasing tank capacity and reducing the amount of scale-forming matter deposited in the boilers over a given run. It also produces increased power at high speed and permits of operating the locomotive at a shorter cut-off. In addition to this, the superheater very largely overcomes carrying water over into the cylinders, which washes off lubricants, and causes lubrication trouble.

"The feedwater heater helps to make long continuous runs successful by diverting a portion of the exhaust steam which would otherwise be wasted, to the boiler in the form of water. This amounts to about 10 per cent, thus making it possible to go somewhat further before taking water, and reducing the amount of impurities admitted to the boiler. In addition, as the heat is returned to the boiler, there is a saving in fuel, as well as an increase in boiler capacity. In diverting a portion of the exhaust steam to heat feed water, a reduction is made in back pressure in the cylinders, which in turn increases the power output of the locomotive by probably 2.5 per cent to 5 per cent. A modern locomotive equipped with a superheater and feedwater heater should be able to handle the same train for possibly a 50 per cent greater distance without evaporating any additional water in the boiler. However, such devices, when engines are idle, standing at terminals, on sidings, etc., are not making these savings; hence the importance of keeping them in use.

"Brick arches and other improvements in fireboxes and boilers have also done much to increase boiler capacity, fuel economy and reliability.

"The booster in many cases will provide the locomotive with sufficient additional power to carry it over some controlling grade on the line, thus fitting it to the service and permitting its operation over a longer run than would otherwise be possible without the aid of helpers. The use of boosters in starting heavy

trains on grades or slippery rail will usually prevent drivers from slipping or spinning, which sets up severe strains in the machinery and undoubtedly produces more wear than many miles of actual running."

209. *Better Materials and Design.*

"Refinement in design and materials of construction has made it possible to build locomotives with ample boiler capacity, sufficient strength of parts and adequate bearing areas, and still keep within the weight limitations. Much has also been accomplished in recent years by improving engine trucks, trailing trucks and spring and equalizer systems, relieving the locomotive of unnecessary shocks and vibrations. Vibration is probably the greatest single cause of failure and regularly exacts its toll of every piece of machinery in operation. One of the most important improvements in recent years that materially reduces shocks and vibrations has been accomplished by using higher grade materials in conjunction with improved design in such parts as connecting rods, crossheads, piston rods and pistons. The side rods and a portion of the main rod are revolving parts, and the others, such as the front end of the main rod, crossheads, pistons and piston rods, are reciprocating parts.

"The reduction in weight in both revolving and reciprocating parts materially reduces the wear on rod brasses and pins. The reduction in weight of reciprocating parts is one of prime importance, for we know there is no other single factor that will cause more vibration and set up more destructive strains than counter-balance, either the lack of it or too much of it. The revolving parts we can balance in all directions as both the parts to be balanced and the counter-balance have a rotary motion. With reciprocating parts it is different; they have a horizontal motion and the balance placed in wheel centers to balance them has a rotary motion; hence all weight placed in wheel centers to balance these parts is overbalance in a vertical direction and produces a disturbing force on the rail. With heavy reciprocating parts in use twenty years ago, it was necessary to balance two-thirds of the weight of these parts. Reducing the weight

of reciprocating parts to less than 1 160 of the weight of the locomotive permits balancing only 50 per cent.

210. Advantages and Economies of Long Runs.

"The advantages and economy of running locomotives over two or more divisions when topography of country and operating conditions permit, are as follows:

"First—Increased mileage. I have yet to learn of a single case where extended locomotive runs have not resulted in increased mileage over a period of time. However, increasing the length of the run 100 per cent does not necessarily mean an increase in locomotive mileage of 100 per cent, but it does usually range from 30 per cent to approximately 100 per cent, depending on operating conditions, or in other words, how the runs fit in with train schedules.

"Second—Reduction in the number of locomotives required. An increase in locomotive mileage is equivalent to a corresponding increase of locomotives and as shown by the extension of runs on the Southern Pacific between Sparks and Ogden, the same 15 locomotives made 68 per cent more mileage per month after they were run through, which enabled them to do the same work as 25 locomotives operating over the old runs.

"Third—Increased railroad capacity. The railroads of the country today are handling heavier traffic than at any time in their history. They are being hampered on all sides by legislative committees, which make it very difficult to finance new facilities and equipment; hence the importance of getting the most out of what we have.

"Reduction in work for locomotives at small outlying terminals permits the reducing of the number of expensive tools required at such points, where they are used only a portion of the time, and permits assembling them at main terminals where they can be utilized to greater advantage, thus reducing the investment in these facilities.

"Fourth—Economy at terminals. Locomotives running over two or more divisions do not require at intermediate points the attention of wipers, hostlers, ash-pit and coal dock men,

machinists, boilermakers, etc. The cost of turning a locomotive after it has made two or more divisions is very little, if any, more than if similar attention had been given at intermediate points and repairs can be made in a more substantial and workmanlike manner, as there are ample time and facilities to take care of them.

“Fifth—Saving in fuel. During the year 1921 about one-fifth of all locomotive coal used, or 25,000,000 tons, was consumed when the locomotive was not doing useful work. Waste of fuel on account of dumping coal fires, and rebuilding fires as well as fuel for keeping locomotives hot is saved, which amounts to a considerable sum. An eastern road reports cost of dispatchment about \$12.00 and that at a particular point, on account of running through, the dispatchments were reduced by 28 per day, thus making a saving of \$336.00 per day or approximately \$10,000.00 a month from this cause alone. The amount of fuel required to keep locomotives hot and prevent freezing at outlying points, in cold climates, is a big item. The amount of coal lost in dumping and rebuilding fires is estimated at from one to two tons per locomotive dispatched, and with coal at from \$3.50 to \$5.00 per ton, this represents an item of importance in the reduction of expenses. On lines using oil this saving is not experienced, but they do enjoy the saving on account of not having to keep engines hot at intermediate points. At one point alone, in cold climate, this has been estimated at \$15,000.00 per annum.

211. Long Runs and Maintenance Costs.

“Now, let us consider the possible disadvantages, increased cost of maintenance and increased engine failures. Maintenance is a factor to be considered in connection with long locomotive runs, since an increase in the daily mileage of motive power and a reduction in the time held at roundhouses would presumably affect the condition of locomotives. For this reason particular inquiry has been made in regard to the average mileage between shoppings of locomotives operated on long runs and it appears where records are available the mileage made

by these engines between shoppings is as high, if not higher, than when operated over short runs.

"It would appear reasonable that we would get as much if not more mileage out of a locomotive if run off in, say two years' time than in three or four, as we know time and the elements collect their toll whether a locomotive is in operation or not. Also, it is a question if the cooling down and firing up strains in a locomotive do not do more damage than fair service.

"In the case cited of the long run on the Southern Pacific between Sparks, Nevada, and Ogden, Utah, since the locomotives went into service they ran off 47,691 miles in ordinary service at the rate of 5,299 miles per month and up to December 31, 1923, had run off 213,380 miles in long runs, averaging 8,891 miles per month. This makes an average total mileage of 261,000 up to January 1, 1924, and will probably average about 300,000 miles before locomotives go into shop for general repairs, which is certainly not discouraging for long runs.

"The question of possible increase in locomotive failures has been watched by those interested in long runs and it appears that such failures apparently are not affected by the mileage which the locomotive makes during its individual run. Analysis of failures shows that the majority take place on the first division and that the mileage of the individual runs has little or no effect upon the number of failures experienced.

"Special attention and care are necessary in making long runs successfully. Much depends on the care exercised by engine crews, inspectors, and shop forces. A locomotive offered for service must be in good condition, which means that all details requiring attention have received that attention and where repairs are made, that they be of a permanent and not of a temporary nature. This latter practice frequently occurs on ordinary runs, in order to get locomotives back to the main terminal. Then, oftentimes, on arrival at main terminal the men are especially busy, or think they are, and let her go for another trip.

"Enginemen should report on blanks provided for that purpose all parts that are not working properly or that in their judgment require attention. This is especially necessary when

crews are changed, so the proper attention can be given on arrival at the terminal.

"Lubrication is especially important and the engineman should give particular attention to this; also, shop forces should see that all parts will lubricate properly.

"On coal-burning roads it is important that the fireman keep his fire in proper condition up to the time he is relieved so that the fireman taking the locomotive will not be put to undue difficulty.

"By building up long runs gradually and supervising closely, these items of lubrication, work reports and fire conditions may be eliminated and no more trouble experienced with them than on shorter runs.

212. More Miles per Locomotive.

"After all is said and done, the consideration of prime importance is, not so much the attainment of the longest possible locomotive runs, as it is to obtain the greatest mileage per unit of time per locomotive owned, with the smallest fuel consumption and the least expenditure for repairs and enginehouse attention. This can best be done by designing equipment to fit the special service requirements, providing boilers of ample capacity, and applying standard devices that will increase the efficiency and reduce fuel consumption. Particular attention should be given to the design of various details, using high quality materials in parts where reduction of weight will minimize the stresses set up in machinery and in track and roadbed. Select the softest natural feed waters available, and chemically test those that contain objectionable impurities, reducing these impurities to a minimum, and provide hot water boiler washing facilities at terminals to reduce cooling down stresses in the boiler and save fuel."

This discussion of Mr. Russell's is handled rather from the standpoint of the engineer than of the operating man, but he brings out many valuable points which will be of use to the student. It cannot be said that this argument makes out a clear case in favor of pooling engines or of operating them over long

runs, any more than that previously quoted clearly demonstrated the superiority of the assignment system. The two views of the question are given so that the student may be in possession of the main arguments presented by experienced authorities on both sides.

It is logical to assume that locomotive runs will gradually be increased in the future, as they have been in the past, and the progressive railroad man will study to devise means of putting locomotives to greater use without sacrificing anything in the quality of the service. The man who continues to do a thing merely because it has become established practice and who makes no endeavor to improve upon the records of the past, will never get very far either on the railroad or in any other line of business.

SOME LONG LOCOMOTIVE RUNS

PASSENGER SERVICE

Road	From	To	Miles
Southern Pacific	Los Angeles	El Paso	815
M. K. T.	Parsons	San Antonio	678
Union Pacific	Kansas City	Denver	640
Southern Pacific	Sparks	Ogden	536
A. T. & S. F.	Winslow	Los Angeles	602
Union Pacific	Council Bluffs	Cheyenne	509
Union Pacific	Council Bluffs	Denver	562
Union Pacific	Denver	Ogden	577
Canadian National	Montreal	Toronto	334
C. M. & St. P.	Milwaukee	Minneapolis	321
Great Northern	St. Paul	Minot	526
Great Northern	St. Paul	Winnipeg	458
Missouri Pacific	Hoisington	Pueblo	338
Kansas City Southern	Pittsburgh	Shreveport	430

FREIGHT SERVICE

Southern Pacific	Sparks	Carlin	387
Southern Pacific	Del Rio	El Paso	453
A. T. & S. F.	Los Angeles	Needles	310
Union Pacific	Ellis	Denver	337
Canadian Pacific	Calgary	Edmonton	180
St. L. S. F.	Memphis	Birmingham	251

FREIGHT SERVICE—*Continued*

Road	From	To	Miles
M. K. T.	Parsons	Denison	278
Union Pacific	Kansas City	Ellis	303
Grand Trunk	Ft. Erie	Sarnia	189
C. M. & St. P.	Chicago	Nahant	209
Great Northern	Havre	Wolf Point	202
I. G. N.	San Antonio	Palestine	260
B. & O.	Cumberland	Parkersburg	205
B. & O.	Connellsville	Willard	264
B. & O.	Willard	Chicago	278

The man who rises in the railroad field is the one who keeps constantly in touch with transportation developments everywhere, and who studies every new proposition which comes up with an open mind. The science of transportation is merely in its infancy; within the memory of the middle-aged man the whole situation has undergone enormous change, and the end has by no means been reached. The full development of the railways to their present state has occurred in less than a century. Within the few years just past, the automotive industry has come into the field, and while the automobile and the motor truck have had some influence on the situation, it is not yet possible to predict how great their effect may be on transportation as a whole.

Within very recent years, persistent agitation has arisen in favor of the extensive further development of inland waterways and this form of transportation may possibly become a factor to be considered in the future. With all of this competition in the field, or in prospect, it is sufficiently evident that the railroads cannot afford to stand still, but, by constantly improving their service and reducing their costs, must continue to prove their right to be considered as the basis of the country's transportation system.

In considering the possibilities of increasing efficiency and of decreasing unit costs, the railroad man must bear in mind that progress along these lines is essential, not optional. When the time comes, if it ever does, when railroad men consider that further improvements in their trade are impossible, the begin-

ning of the end of rail transportation will be at hand. There is no reason apparent at the present time why the railroads should not continue to be the main stay of our transportation system for an indefinite time to come, and if the business is taken from them by highway or water vehicles it will be because the rail carriers have stood still while the others progressed.

The interest of every railroad man in increasing the efficiency of operation is personal and intimate. If the business in which he is engaged goes into a decline, his will be the principal loss. There is no reason to fear that progress in the perfection of more efficient equipment and the development of more effective operating methods will not continue in the future as it has in the past, but the point which is made here is that the individual who hopes to progress in the railroad field must be a leader in the program of improvement.

In the matter of assignment of power, or of lengthened runs, as in every other question of railroad operation, the executive should be ever ready to investigate any new method or practice suggested, to analyze the situation on his own railroad in relation to the possibilities of the suggestion, and to adopt whatever proves best without regard to tradition or precedent.

CHAPTER XXXV

MILEAGE BETWEEN SHOPPINGS

213. Standards of Performance.

It is very necessary that standard figures be set for the mileage which engines are expected to make between one general shopping and the next. Such standards must, of course, be made to apply only to a single class of power, and they must further be varied to take care of conditions of operation. It would be useless to expect an engine running in a bad water district to make the same mileage with a set of flues that her sister engine would make in a good water district. Standards of mileage, then, should be set for each class of power, and for each set of conditions under which engines of the same class are operated.

The mileage made between shoppings will vary widely on the various railroads, even when the power is of comparable design and when conditions of operation are fairly similar. Some railroads specialize on running repairs with the purpose of keeping engines in service the maximum length of time, while others hold their running repair forces at a minimum and place dependence in the shops to restore the mileage to the engines at more frequent intervals. The decision as to which policy is most efficient and economical will depend, largely, upon the repair facilities with which the railroad is provided. If the terminal facilities are inadequate, while the main shops are well equipped and efficiently operated, it may well be that economy is promoted by placing the greater dependence upon general overhauls.

As a general proposition it may be said that thorough repairs at roundhouses, at the end of each trip, promise the best results in the way of performance and of low cost of total

repairs, but the rule cannot be laid down as final. Engine failures are costly occurrences, and are largely due to neglected running repairs. The road which spends most of its maintenance appropriation in the roundhouse will have fewer engine failures and will secure the maximum mileage between shop-pings. This practice can, however, be carried too far. When an endeavor is made to keep engines in service after their legitimate mileage has been made, instead of shopping them and restoring them to general first class condition, the result is often excessive cost of repairs in relation to the service rendered, and greater total detention from service than would occur if the unit were sent to shop at an earlier date.

There are many instances of record where engines have been kept in continuous service until the mileage made has equaled several times that which might reasonably be expected, but it is safe to say that in all such cases the cost of repairs per unit of service has been excessive, even though the standard of performance may have been maintained. It is easily possible to give an engine a piecemeal overhauling in the roundhouse without holding it out of service for long at any one time and without running up the cost of repairs for any one trip to the point which would constitute a shopping, but such practice is not economical.

214. Relation of Mileage to Shop Plan.

On every railroad there should be a comprehensive plan for the shopping of engines based upon their expected mileage. It is a comparatively easy matter to figure a year or even more ahead as to what units of power will require shopping, when standards of mileage are set and when the roundhouses forces understand that they are expected to get the full service from each locomotive, barring accidents. With such a system it is possible to properly divide the mechanical forces between shop and roundhouse, and it is further possible to figure very accurately just what engines will be coming to shop during any month and to line up material and forces to handle them with economy and dispatch.

As will be seen in a later chapter, a comprehensive and accurate forecast of the repairs which must be handled by the shop, upon which may be based the plan of shop operation, is one of the principal essentials of efficient shop management. The making of such a plan depends upon a well worked out system of expected mileages and, further, upon close adherence to the schedule of mileages. If the standards of mileage are set too high, the locomotives will either come to shop before they are expected and before the material is ready for them or the shop pits vacated, or they will be kept in service after their condition makes them inefficient in operation and a heavy burden on the roundhouse forces and facilities. If, on the other hand, the mileages are set too low, the shop will run short of work and unnecessary money will be invested in materials.

An engine should not, of course, be shopped merely because it has made its expected mileage, while it is in condition to give good service, any more than it should be kept in service after it has become inefficient in service simply because it has not made the standard mileage. It is possible, however, to closely regulate the mileage standard, so that very few engines will either require shopping before their mileage is made or will run far over their allotted time. The mileage which engines will make between general shoppings depends upon their design, the service in which they are used, the climatic and water conditions under which they operate, the manner in which they are handled by engine crews, the quality of the shop repairs, and the degree of attention given them at the end of each trip.

The unit ordinarily used, locomotive miles, is not properly fitted to figuring the service given by engines between shoppings any more than it is to computing the cost of repairs. However, no other acceptable unit has been developed and mileage must be used until such time as a better standard is established. The ton-mile basis, which fits very well for repairs, is not so well adapted to measuring service between shoppings. The principal factor in determining the useful service life of a locomotive is the life of flues and firebox sheets, and this is less influenced by loads hauled than by time under steam.

CHAPTER XXXVI

REPORTS AND RECORDS

215. *The Value of Records.*

The railroad man of twenty-five years ago kept most of his records in his head and considered any report other than the payroll entirely superfluous. That day has passed, however, and records and reports are as essential on the railroad of today as they are in the bank. The thoroughly practical man often has an inherent distaste for figures and for writing, but if he expects to progress in the modern industrial world he must overcome this dislike and become, not only a reader and a writer of reports and a keeper of records, but a lover of them.

The higher executives in any business depend almost entirely upon the reports which are made to them for their knowledge of what is going on, and their opinions and action are based upon what the records show. It is evidently impossible for the general manager or the superintendent of motive power to keep in close touch with all of the activities in his department through personal observation, and he must depend upon the reports made to him by the men in actual charge of the work on the ground.

The importance of records and reports is twofold. They give the minor executive an opportunity to show his superior in definite form just what he is doing; and they place the higher officer in possession of all the information which he must have to administer his position properly.

It may seem to the foreman that he is required to make out a large number of reports and to keep very elaborate records of things which seem to him of little importance, but all of this information has a very definite value, and the railroad could not be operated without it.

216. Importance of Accuracy.

One of the principal faults which has been found with railroad reports in the past was their inaccuracy. When the railroads went into court some years ago to defend themselves in rate cases brought against them by various States, the judges invariably sent them back for more accurate and detailed figures to support their contention that freight rates and passenger fares were not higher than was necessary to provide an adequate return upon the money invested in railroad property. The whole valuation program was instituted and carried out, at the expense of hundreds of millions of dollars to the taxpayers and other hundreds of millions to the railroads, for the sole reason that the books of the railroads did not clearly establish the truth as to the money which had been invested in them, and as to the value represented by the property in present use.

Inaccurate records are not only valueless, they are worse than useless, because they present as facts things which are not true. The value of accuracy applies to every record kept and every report rendered, whether it be a repair card covering work done on a box car or the annual report of all the revenues and expenses of the railroad. If the Interstate Commerce Commission deserves credit for any one act as of greater value than any other it has performed during its existence, it is for requiring the railroads to make systematic reports covering certain features of operation and maintenance. As an example, we, as railroad men, may have our personal opinion of Federal boiler inspection and of the men who come around and tie up engines when we consider them in suitable condition for service; but we must admit that the inspection rules and the necessity of regularly and uniformly reporting the condition of each individual locomotive have been a very large factor in improving the general condition of power and in reducing accidents.

From the standpoint of the mechanical man, the records and reports which have to do with the handling and repairing of engines and cars are of the greatest interest, although as a man rises in the service he must also study the records which

have to do with operation in all of its branches, and finally with the problems of general accounting and financing.

217. Force Records.

The mechanical executive deals principally with two items, labor and material. The keeping of force records, mechanical payrolls, and labor distribution is purely a mechanical department matter, and while the actual accounting is usually done in the stores department, shop and roundhouse executives are vitally interested in these records and in the reports which are made from them.

All data which are accumulated for any purpose on the railroad must be based upon original information furnished by the man on the job. Upon the accuracy of such basic data depends the value of all the records and reports and computations which are subsequently made. The origin of all labor charges in the mechanical department is the time card of the workman and the distribution of his time as between jobs. In most modern shops the time clock has replaced the older and less accurate block or check system, and the record of time worked by each individual workman, as printed by the clock on tape or cards, is the basis of the payroll. So far as the individual is concerned, the payroll is the all-important document, but from the standpoint of accounting and statistics it is merely a means of collecting total labor charges.

So far as records and reports are concerned, it is the distribution of labor charges as between individual units of equipment, between expense accounts and between separate jobs, which is the important item. Every cent which is paid out as wages must be accounted for in this distribution, and must be charged, first to some specific job, and next to a specified account. The accounting department, which actually handles the accumulation of these figures, is dependent upon the men in the mechanical department for all of the data upon which this distribution is based.

Until a very few years ago, the methods used for distributing the labor charge on the railroads were exceedingly crude

and inaccurate. A rough division of the time spent by workmen on the different engines, or on other equipment, was made on the basis of the individual workman's estimate of the time consumed on each job. When such figures were accumulated and collected into reports, supposed to show the cost of locomotive or freight car or passenger car repairs, the inaccuracy of the original information made the records useless for analytical purposes. Within the last few years the railroads have come to realize the value of accurate figures showing what has been done, as a guide to determining what may or shall be done, so that improved systems of accumulating the basic data have been introduced in practically all shops.

With every passing year railroad men are coming to depend more and more upon figures of performance to assist in the development of more efficient practice, and constant improvement in methods of shop accounting is to be expected. The prospective mechanical executive must not assume that the keeping of records is purely a clerical job, which it is beneath his dignity to understand, but must make a study of the figures which represent performance, as well as of the methods and practices of actually accomplishing the work.

The clerk who actually gathers the information upon which shop records are based seldom if ever has the mechanical and general knowledge necessary to accumulate the information in accurate form, unless he has the assistance of the foremen and shop executives. In the distribution of charges between engines, shop orders, or other original charge items, the foreman should take an active and intelligent interest, so that the figures which go to the accounting department from his shop shall represent the true conditions.

It is unnecessary to go into details as to the forms used and the methods employed in gathering the original information as to labor charges in the shop. Practices differ in detail on the various railroads, and there is nothing complicated about the matter to the man who understands the principles of the Interstate Commerce Commission's accounting system, which is standard for all railroads. This system is described in some

detail in another chapter, and it will pay the student to become well acquainted with the various accounts and with the charges which are properly made to them.

Aside from the records and reports which have to do with the money paid out in wages, there are other force reports which are, or should be, kept in every shop. It has been pointed out elsewhere that excessive turnover of force is one of the principal causes of force inefficiency. The shop which is constantly called upon to break in new men in large numbers cannot be efficiently or economically operated. It is important, therefore, that every shop should have a turnover report, which shows the number of men employed each month to keep up the working force in all of the many departments. These force reports should be designed to show, by individual foremen, the number of men who quit or are discharged and the causes for their leaving the service. Every foreman should make an intensive study of the turnover in his own department, to determine where the fault lies. If it is in working conditions, an effort should be made to improve them or to set up other advantages which will offset them.

There used to be an old drop pit in a roundhouse on one of the western lines which was probably responsible for more men leaving the service than all other causes put together. This drop pit had been constructed without any provision for drainage, and as the ring pit was not of sufficient depth, water always backed up and stood level full in the drop pit. Whenever there was a pair of wheels to drop, the roundhouse foreman had to pick one of the machinists to do the job. If there was some man he wanted to get rid of, he would get the assignment; and if there was not, the youngest man on the force usually got the job. That drop pit probably cost the railroad more, in men hired and fired, than it would have cost to build an entirely new roundhouse layout.

A good mechanic likes good tools and convenient facilities, and if possible he will try to get employment in a shop where they are provided. This does not mean that the good mechanic will always seek the big modern shop where all of the tools and

appliances are of the most approved design, but it does mean that he will avoid the shop where the equipment is not kept in good repair and where he is required to work among unhealthy or unpleasant surroundings.

Often the foreman will find the reason for excessive turnover in his department in some peculiarity of his own. He may have an unpleasant way of criticizing the work which does not come up to the desired standard; he may lose his temper too easily and reprimand men when a calmly-made suggestion would accomplish the desired result; or his discipline may be too lax at times, so that when he is compelled to assert his authority the action is resented. All of these things the foreman can study out from the turnover report, and once he is in possession of the reason for men leaving his department he is in a position to apply the remedy.

218. Material Records.

In the repair of railroad equipment, the cost of materials is often as important as the labor. The material requisition, written by the foreman as the storekeeper's authority for issuing the material, is the basic report upon which all of the material accounting is founded. The foreman's requisition book is his checkbook. By means of the forms it contains he draws money out of the railroad treasury. It is very important that the foreman get the proper angle on this material-drawing authority which is vested in him. Every piece of material used in the repair of equipment, every item of supplies drawn for use in the shop, represents the expenditure of money.

On the larger items which the foreman draws, such as locomotive cylinders, driving boxes, or tires, there is a very accurate check and very little opportunity for waste or extravagance; but on the innumerable smaller items there can be very little check, except that kept by the foreman himself; and it is these small pieces of material which may total into a very large item of waste.

It is easily appreciated that, from the company's point of view, the conservation of materials to the greatest possible

extent is highly desirable; but the foreman or other executive should also understand that the saving of material helps him even more directly. The amount of money which a railroad may spend is definitely limited by the amount which it earns. The allotment of allowable expense, particularly to the maintenance departments, is set by the higher officials and must be held within certain ratios with the operating revenue. Every unnecessary dollar which is spent for materials means one less dollar to spend for labor; and when a department or a shop is wasteful in the use of materials it is cutting down by just so much the money available for payroll. Every foreman and shop superintendent likes to keep up his working force, and the most effective measure which he can take to do so is to keep down material charges to the lowest possible minimum.

Every mechanic prefers to work with new materials and, without thought of the cost, many serviceable parts are thrown into the scrap when slight repairs might fit them for further use. The autogenous welding processes, which have come into general shop use during the past few years, provide a means of saving large amounts of material which were formerly of no further use, and every foreman should make a study of the possibilities of these and other methods of reducing material charges, so that he may have more money with which to employ men.

The foreman is not only responsible for seeing that no new material is drawn when it is not actually required, but it is also his duty to see that each requisition drawn is charged to the proper engine number or account. In every shop there is a large amount of expense which cannot be directly charged to any special engine or account, and which must go into the prorated account, "shop expense." It should be the business of the foreman, however, to see that as little expense as possible finds its way into this overhead account. The larger proportion of labor and material which is charged direct to the account or unit of equipment benefited, the more accurate will be the accounting and the more valuable the records of cost.

The material requisitions are, ordinarily, handled by the

stores department, and the pricing of the requisitions and distribution of the material expense is performed in a stores accounting department. On some railroads, however, the material accounting is handled by the mechanical department accounting forces. Whether this matter of clerical detail is handled by one department or another is not material; in the end all of the material used in the repair of equipment or in the upkeep of shop tools is charged against the mechanical department accounts, and the executives of that division are responsible for the expenditures.

219. Accumulation of Shop Charges.

The information as to charges against individual items of equipment and as against primary accounts, as recorded on the distribution cards of the workmen and on the material requisitions, is accumulated in the accounting offices on what is usually called a blotter. This is merely a large column-ruled sheet or book where the separate charges to each engine or each account are set down and totaled. From this blotter is made up the statement which shows the total charges by accounts and by individual units of equipment. This final statement of costs is the record of performance for the shop, roundhouse, or car department, and from it are prepared all of the various statements and reports having to do with the cost of repairing and handling motive power, rolling stock, and other equipment.

It is understood, of course, that these costs are finally consolidated with similar figures for all divisions and all departments, and are made up into reports and records which show the total operating expense for the railroad. The importance of accuracy in the original figures will be readily understood. The best auditor in the world can only take the data which are furnished to him by the men on the job and accumulate them into comprehensive reports; he is helpless to detect incorrect charges to accounts or to individual units of equipment, and his reports must show exactly what the time cards and material requisitions show. The accounting department will detect errors in extensions or addition; it will see that the total expense

distributed agrees with the total of the payrolls and the material issues; but further than this it cannot go. The accuracy of mechanical figures is up to the foreman and the clerks who are assigned to assist him.

220. Cost Reports.

The cost figures accumulated in the mechanical department are handled in various ways. On some railroads very complete reports of costs by departments are prepared, so that each foreman may know just what expense he is charged with. This should be the case on all railroads, and it no doubt will be within a few years. One reason that foremen, in the past, have not been more interested in costs, is that few reports have been furnished to them showing specifically the expense for which they were responsible in relation to the output of their departments.

On all roads the charges to accounts and to individual units of equipment are compiled so that the total cost of putting an engine through the shop, of maintaining a locomotive in service, of overhauling box cars, or of repairing passenger cars, is known. This information is, or should be, put in the hands of all foremen, so that they may become familiar with the costs of overhauling the various types and classes of equipment and with the relation of such costs to the performance rendered.

The methods used in railroad shops in the past, and at the present, have been crude and inaccurate as compared with those developed in the factories, but improvements are being made from year to year and the executive of the future will have more and better figures to work with than did his predecessors. It is not by any means easy to establish a comprehensive cost accounting system in the railroad shop, nor is it a simple matter to set up units for measuring output. Some of the difficulties can be well pointed out by quoting from a paper read before the New England Railroad Club at a recent meeting by Mr. J. E. Slater, Special Assistant to General Manager, of the New York, New Haven & Hartford Railroad.

“On a railroad there is no time for looking at figures solely

because of their possible academic interest. In other departments statistics are found valuable and useful because they are guides and aids to observation. They supplement that which the supervisory officer can view with his own eyes. They point the finger at weak spots. Therefore, in determining whether statistics of any kind are necessary, we should first ask ourselves if shop practice has any need of data supplementing that which can be learned through the observation of actual conditions. A large number undoubtedly will answer in the negative. That same answer has been made by many transportation officers as well, but such a statement is based upon a hope rather than upon a fact. A statistical analysis has brought to light many a bad condition which had escaped the observing eye of the man who had no need of figures and reports. I have in mind a study which was made several years ago of a particular phase of engine-house operation in which a very large amount of overtime was being earned. The mere figures in themselves were so conclusive that the overtime was eliminated immediately the information was in the hands of the officer in question. Although he had observed that operation at that particular point many times before, and though it was under the constant view of his subordinates, it had never occurred to any of them that such a saving was possible.

"There was a day when, if the equipment was kept in reasonably good condition, the cost of that maintenance was allowed to take care of itself. That day is past. In all angles of railroad activity we must have comprehensive information to indicate what we are getting for our money. The spread between revenues and expenses is so narrow that we must assure ourselves that each dollar of that expense has produced its return.

"One further point I would bring to your attention. For the railroads of the United States, the ratio of maintenance-of-way expenses to operating revenues in 1913 was 13.1%; in 1923 it was 12.9%. In the same period, the ratio of transportation expenses to operating expenses increased from 34.4% to 36.9%. On the other hand, the maintenance of equipment ratio increased from 16.1% to 23.4%. These figures in themselves do

not signify that there has been an excessive increase in maintenance of equipment expenses. Nevertheless, they put the question squarely to the mechanical officers to justify the startling differences. While there is no doubt that the increase in the size of the locomotives, in the number of appliances, and the increase in the intensity of the work are important factors, it is impossible to judge accurately to what extent the greater increase in mechanical expense is due to these factors. With the scanty amount of information available, it is difficult to tell anything about the maintenance of equipment expenses. Is it not common sense to attempt to analyze these expenses before we condemn entirely the use of statistics in mechanical operations?

"There is no question but that the development of statistics in transportation has been much faster and more successful than in maintenance of equipment. We now have adequate methods of checking station, yard, and train performance, and the general efficiency in the use of man power and equipment. In the case of the equipment, we have statistics of output admittedly questionable and a few statistics of costs which raise more questions than they answer.

"There are two reasons for the slow development of statistics of mechanical operations:

"First, it is obvious that the operating officers can observe but a very small percentage of the work under their immediate jurisdiction. The superintendent has many stations, several yards, and frequently hundreds of trains. He cannot hope to observe more than a small percentage of the operation of these units. On the other hand, a shop superintendent or engine-house foreman is in such close contact with the work under his jurisdiction that there is much more opportunity for personal supervision.

"Second, there is the absence of standardized units of performance in mechanical operation. In the maintenance of locomotives and cars, every job differs from every other job. Costs cannot be divided by the number of engines handled, by the number of engines repaired, or even by subdivisions of

these, because of the wide variation even in the smaller units of work. In my opinion, it has been this factor more than any other which has caused the slow progress in the development of mechanical statistics which results in the chaotic situation today, where, from a statistical standpoint, it is impossible to check the efficiency of the mechanical department in the use of the money allotted to it.

"Yet we do have some mechanical statistics. Whether he desires it or not, the mechanical officer will be checked by the data available. Such data should be informative. Today they are not. Let us then analyze the statistics which are available and determine to what extent they give accurate information and whether it is possible to make such changes that a proper analysis can be made.

221. Locomotive Output.

"The statistics of output of our locomotive shops are confined for the most part to the number of engines turned out. The classification of locomotive repairs adopted by the U. S. Railroad Administration has been continued, not apparently because it has intrinsic merit, but because no better classification has been suggested. Although most of you know the classification under which we are now working, I will describe it briefly for the benefit of those who may not have the information in their minds.

"A Class 1 repair involves the complete renewal of a boiler or new back end, with a full set of new or re-set flues, tires turned or new, and general repairs to machinery and tender.

"A Class 2 repair involves a new firebox, or one or more shell courses or roof sheet, flues new or reset, tires turned or new, and general repairs to machinery and tender.

"In a Class 3 repair a full set of flues must be installed with necessary repairs to firebox and boiler, tires turned or new, and general repairs to machinery and tender.

"A Class 4 repair requires but a part set of flues, with light repairs to boiler or firebox, necessary repairs to machinery and tender, and tires turned or new.

"In a Class 5 repair, the tires must be turned or new, and necessary repairs made to boiler, machinery, and tender.

"An analysis of this classification will indicate that while it is intended that heavy classes of repairs shall mean heavy work for the entire locomotive, and lighter classes of repairs shall cover light repairs for all parts of the locomotive, as a practical matter the classification is largely controlled by the boiler and firebox work and the turning of tires. The work on machinery and tender is not controlled. Furthermore, the classifications are so broad that in themselves they give little idea as to the amount of work which has been done. If an engine-house turns a set of tires and does the necessary work on the machinery and boiler, it is given credit for a Class 5 repair. If, in a shop, the flues are not installed new or reset, but very heavy repairs are made on the machinery, possibly involving new cylinders, extensive rod work, etc., it receives credit only for a Class 5 repair.

"In connection with the Class 3 repair, there may be nothing done on the boiler but the installation of a new set of flues, yet the same credit is allowed as when a new set of flues is installed and the firebox largely renewed. I do not think it is necessary for me to expand at great length on the lack of value of the present classification. Every mechanical man can recall numerous cases of Class 5 repairs costing more than Class 3 repairs, and one Class 3 costing twice as much as another at the same shop and for the same class of locomotive.

"Frequently there are attempts made to equate classes of repairs to standard units. A Class 1 repair is assumed to have three times the weight of a Class 5 repair, a Class 2 two and one-half times, etc., the total output being expressed in equated Class 5 repairs. I have tried to do this myself and at last arrived at the conclusion that such a method is not worth the time taken to perform the work. An example of the uselessness of such attempts came to my attention very recently. A statement was prepared analyzing the costs of classified repairs at one of our shops. The classified repairs were equated to Class 5 repairs and a cost per unit obtained for each month of the year. Using the first month as a basis, and comparing the re-

sults of the other months with it, it was found that the costs for the later months were considerably lower than the costs for the first months. The saving for the eleven months was found to be in the vicinity of \$300,000.00. The statement was given to me to check. We set up another statement using the last six months of 1923 as a base, instead of January, 1924. The method of equating was slightly different, but based upon the actual differences in cost of the various classes of repairs during the year 1924. This statement indicated that instead of there being a saving of \$300,000.00 there was a loss of approximately \$350,000.00. Which of the statements is correct neither I nor anyone can tell! The example, however, clearly shows the futility of the present system of classifying repairs as a measuring stick of output.

"In spite of the well-recognized fact that the present classification furnishes little information as to the work done, it is universally used and is one of the few statistics which we have today governing our locomotive maintenance problem. It is an excellent example of the weakness of our present mechanical statistics, for it provides just enough information to provoke questions, while it answers few of them. In my opinion, a statistical statement should not only present certain facts, but should, as far as possible, answer most of the questions which are likely to be raised. For example, if the statement, in addition to giving cost of repairs and the number of Class 3 repairs also indicated certain subdivisions of Class 3 repairs which would indicate to what extent the repairs were heavier in one period than in another, the explanation would be on the face of the statement.

"You will say that it is easy to criticize the present classification, but a much harder proposition to provide anything better in its place. In answer to that, I will say that there are two ways by which the statistics of output of locomotive shops can be improved, either one of which is a distinct step in advance of the present method. The first method is that of breaking up the two largest and most important classes, namely Classes 3 and 5, into several sub-groups, in accordance with the character

and amount of boiler and machine work done. A segregation made by one of the New Haven staff contemplates six sub-classes under Class 3 and four under Class 5. For the Class 3 repair, boiler work is divided into three sub-classes and the machinery into three sub-classes. The heaviest boiler work would involve the renewal of sections of a firebox, such as a half or quarter of a side sheet, door sheet, or throat sheet. The medium class of boiler work would involve patching rather than renewals. Under the light boiler work there would be no firebox work. Under the heavy machinery work there would be involved new cylinders, pistons, valves, guides, crossheads, valve motion, as well as other heavy work on rods, shoes and wedges, driving boxes, etc. This would be work involved primarily in the superheating of engines formerly using saturated steam.

"The medium class of repair would include heavy machinery work on locomotives not being superheated, involving a new cylinder or cylinders re-bored and re-bushed, frames re-bolted, and work of the same class on shoes and wedges, driving boxes, rods, etc. The light class of repair would involve no new cylinders, but only the necessary work in building up, facing, grinding, or aligning cylinders, pistons, valves, guides, crossheads, rods, etc.

"In Class 5, the boiler work and the machinery work are each divided into two classes—heavy and light. The heavy boiler work involves patching the firebox, while in the light class of repairs no patching is required, but only the necessary renewal of stay bolts and other work following the test.

"Under the heavy machinery work there would be new cylinders or cylinders re-bored and faced, together with piston heads built up, rods ground, and guides either new or built up. It also involves the overhauling of the valve motion and crossheads babbitted and planed. Under the lighter class of repairs there would be no work on the cylinders and only necessary work on rings, guides, rods, valve motion, etc.

"While this particular method may be subject to criticism and there will be many differences of opinion among mechanical officers, I think it will be generally admitted that the present

classes are so broad that they can be divided into several sub-classes. Whether it is necessary to divide Class 3 repairs into six groups and Class 5 into four groups or not, the tremendous range in the average cost of these repairs makes it obvious that some natural subdivisions can be made. Such subdivisions would indicate clearly the causes for the differences in the cost of making classified repairs, and would tend to cut down to a very large extent the differences in the cost per engine. With the additional information as to the character of boiler and machinery work, many questions would be answered on the face of the report. This particular method also has the advantage of using the present classification of locomotive repairs, and the information can be developed from the data on the shop report. Furthermore, the method has the advantage of being applicable universally, and it is possible, if comparisons are desired, to go back and work it up for past periods.

“On the other hand, it has the disadvantage of being subject, though in a less degree, to the same objections as have been mentioned covering the present classification of repairs. Even in the sub-classes there would be some difference in the cost of repairs. It would not provide a standardized unit of performance. Nevertheless, it represents a decided step in advance of the present method, and has the advantage of being applicable for use on any railroad at any time without any additional expense for clerical work.

“The second method is that of equating the classified repairs on the basis of standard hours. Under this method the normal of Class 3 repair would be based on a certain number of standard man-hours. The standard man-hours would represent the total hours under bonus or piece work scheduled necessary for the work. The actual output is expressed in percentages or ratios to the standard, being based upon the ratio of the standard hours of actual work performed to the standard hours of the normal Class 3 repair. For example, let us suppose that the standard hours of an ordinary or normal Class 3 repair is 4,000. Let us then assume that the standard hours of an actual Class 3 repair are 4,400. The output would be increased not by one

Class 3 repair, but by 1.1 Class 3 repairs. Likewise, if the standard hours of an actual job amounted to but 3,600 hours, the output would be increased by only .9 of a Class 3 repair. In this manner, since the standard hours are an absolute and unchanging measuring stick and are not affected by any difference in the efficiency of the men, there is provided an absolute method of equating the differences in the amount of work done on different locomotives. In days gone by, classifications were frequently based on the amount of money or man-hours actually spent. The objection to this basis, however, is in the fact that the more inefficient the men and supervision of the shop, the heavier the class of repairs as shown by the report. When the work is expressed in standard hours, however, there is furnished an equation factor unaffected by the efficiency of the men, changes in wage rates, or other like items.

"This method, however, is possible of application only when there is some cost time-keeping or bonus system, and where the operations are currently tabulated and the standard hours applied to them. Fundamentally, it would be possible to obtain the information where piece work systems are in use, but the piece work system in itself does not necessitate the compilation of what the man does, coupled with the length of time taken to do it. Under a bonus or a cost time-keeping system, such information must be compiled in any event, so that it is available for other uses without greatly increasing the clerical work. Such a basis is not susceptible to universal application. The standards would necessarily differ with different shops. This, in itself, however, should not be a determining factor, since it is generally recognized that it is impossible to make comparisons between shops on any but the broadest possible lines, and such comparisons are usually fruitless."

The preceding quotation, and the one which follows, both from Mr. Slater's paper, should not be considered as a solution of the problem of measuring shop output, but should be studied for the merit which they contain. The practical man will see at once that, in this analysis, it is the viewpoint of the statisti-

cian and the accountant which is emphasized, while that of the shop executive is subordinated. Accounts and statistics should be kept and reports compiled and rendered to assist the executive in his administrative duties, and whenever figures do not contribute to this end they are valueless so far as the improvement of operating efficiency is concerned. The student should read these extracts with a view to gaining an understanding of the problem as it appears to the mind of a trained analyst who has had no experience as an executive, and not with the idea of applying the plan outlined to the solution of his problem.

222. *Locomotive Costs.*

“One of the greatest defects in our present accounting system as far as maintenance of equipment expenses are concerned, is in the combination of classified and running repairs in one account. One of the first segregations which any road should make in its Account 308, Locomotive Repairs, is a division between classified and running repairs. These two groups of expenses are controlled by different sets of circumstances. For the most part, one is performed at the shops and the other at engine-houses. One is governed largely by the mileage over a period of many months—the other by current mileage. One is primarily on a production basis—the other on an emergency basis. One should be measured by the amount of work put on the engine, while the other can be measured by current locomotive miles or other like units.

“The second subdivision should be between types of locomotives. This information is valuable, not only because the cost of maintenance will naturally vary with the weight, size and class of service in which the engine is engaged, but is also valuable to the management in its consideration of future purchases of power. Everyone knows that the maintenance cost per locomotive mile or per 1000 ton miles of different types of locomotives of approximately the same tractive effort will vary considerably, and it is highly important that the maintenance costs should be on such an accurate basis that the management can take these facts into account when purchasing new engines.

"In connection with the division of the repair costs among the classes of locomotives, and particularly when this is carried to a cost for each locomotive repaired, it is of the utmost importance that the assignment of costs should be as complete and accurate as possible. All mechanical men are familiar with the division of expenses that was obtained under the old system, in which the men designated the number of hours spent upon each engine. On almost every railroad there are classic examples of large amounts being charged to an engine which had not for a long period of time turned a wheel or which had been stored. On the other hand, when an accurate allocation of expenses is desired, there is a great difficulty in assigning all of the expenses or even a large portion to individual engines. If a knowledge of the costs of repairing the individual engines in a shop is of any value whatsoever, it is worth while to have the clerical work in preparing these data made important and not incidental.

"In this connection, I believe it will be found that better records will be obtained where the accounting work is done under the jurisdiction of the accounting department by a shop accountant stationed at the shop, than when it is done by clerks on the mechanical department payroll. When the accounting is done by the mechanical department employees, adequate supervision is rarely given it, since the work is not the fundamental job of the mechanical department. On the other hand, it is the principal task of the accounting department to obtain accurate and complete records. Experienced supervision is provided to see that the records and reports are correct. New methods of doing the work are studied and applied. It has been our experience that with the accounting work done by the accounting department better results are obtained.

"I would go further, however, in dividing the cost of locomotive repairs and would so segregate them that I would know the cost of the maintenance or renewals of various parts of the engine. Under this system I would have the actual charges to the boiler, machinery and tender separately, and in addition, subdivisions of each one of these as follows:

"The boiler would be divided as to shell, firebox, tubes and

other parts; the machinery as to running gear, valve motion, frames, cylinders, rods, spring rigging, brake rigging foundation, engine and trailer trucks, cabs, boiler fittings, steam pipes, throttles, etc., air brake equipment, and miscellaneous; the tender as to cistern, underframe and trucks. In addition, there would be separate costs for the unwheeling and stripping of the engine and the final painting.

"With this information, and with further segregations which can be made when desired, it would be possible not only to analyze to a better degree the cost of individual repair jobs, but to have available accurate information as to various types of parts. All mechanical men have their opinions as to the best valve motion, and presumably these opinions take into account the cost of maintenance. Yet the officers' data are based upon observation and such information as may be derived from checking the issues from the stores department over a period of years. The same is true of many other parts.

"A question will be raised as to whether the expense of compiling the information will be justified by its value. My answer to that is that as far as the system on the New Haven is concerned, it will not require any appreciable increase in accounting expense, most of the data being available now from the bonus record, the only additional work being in adding several columns instead of one or two. Here, as in answer to many other questions on mechanical costs, I would say that since we have practically no information now, we cannot say that such additional information will not be worth the expense of compiling it. We do not know whether the expense is justified or not. In view of the enormous expenditures for locomotive maintenance, we should make the attempt before we condemn in wholesale fashion any method of analyzing expenses more accurately.

"We usually think of costs in our own shops in terms of labor and material, and I fear that very frequently the items of unassigned and shop expense are not analyzed. I question whether it is necessary to make any detailed analyses of these items currently, since they will be controlled to a large extent

by the amount of production at the shop. Nevertheless, in view of the fact that shop expense will amount to 25 or 30% of the cost of assigned labor and the unassigned expense at some points is very large, we should at least once or twice a year have a complete segregation of these items and an analysis made of them. One of the largest items of shop expense is that of the power house. It is conceivable, especially at smaller shops, that the necessary power for driving the engines and for operating air compressors, etc., could be purchased at a less cost than that of the operation and maintenance of a small plant which possibly uses machines of an obsolete type. The question of overhead labor should also be given occasional analysis and some conclusion reached as to the proper relationship of the cost of this item to other expenses.

"In addition to shop expense, there is the question of the use of machinery. Large locomotive shops are filled with expensive machinery and there should be some effort to determine whether the purchase of machinery has been justified. This should be done not as a post-mortem examination, but as an aid in the purchase of future machinery and also with a view of re-locating machinery in that or some other shop where it can be used more intensively. At commercial shops where cost accounting systems are employed, overhead is charged for the machine and the space it occupies on the basis of the time in use. No such system is necessary in a railroad shop, but I see no reason why a time study cannot be made periodically to determine the number of times machines are used and the cost in fixed charges per operation. It has been my observation that we are likely to go to either of two extremes—either we assume that we can make any item of material cheaper than we can buy it, or we assume that we can make nothing as cheaply as we can buy it. The best way of deciding this point accurately is to test out the proposition and take into account the fixed charges per operation on the machines used. This will provide many surprises where there are expensive machines without intensive use of them.

"There is one other way of checking shop costs: by the per-

formance of the locomotives after they have come from the shop. It is a general practice to assign a locomotive an anticipated mileage up to the next shopping, and a comparison is made of the actual mileage with the anticipated mileage. There are many other ways and means, however, by which the shop work can be checked. We have found it exceedingly interesting to keep a chart showing by individual locomotives the number of days out of service and the days when there were failures. Poor shop performance is frequently brought out by the large number of days that the engine is out of service for running repairs, and an analysis of the cause of the detention for running repairs will indicate wherein the shop failed to do its work properly. From the standpoint of general performance of all locomotives turned out of the shop, it will be found of interest to compare the shop costs in various periods with the performance in the various classes of service. For example, the freight locomotives can be checked on the basis of the gross ton miles per train hour, the miles per locomotive day, the locomotive miles between shoppings, the fuel consumption per 1000 gross ton miles, and the locomotive miles per failure. The passenger locomotive can be checked by the percent of passenger trains on time, average miles per locomotive per day, miles between shoppings, pounds of coal per passenger car mile, and miles per locomotive failure. The switching engines can be checked by the miles per day, the miles per failure, the miles between shopping, and the pounds of coal per switching locomotive mile. In other words, in any analysis of shop costs from a standpoint of management, we should not confine our attention to the cost per locomotive, but must go further and compare these costs per unit of output with the performance of the engines after they have been turned out. The output may decrease and the cost per unit of output increase, but this may be due to improved standards of maintenance and to more rigid inspection, which in turn, will result in a far better performance after the engines have been put in service. This has been the actual situation on more than one railroad under my observation.

223. *Passenger Car Repairs.*

“When we turn to the statistics of passenger car repairs, we find an even more dubious case than that of the locomotive repairs. Although the classification of repairs of locomotives can be criticized, it has at least been standardized. In the case of passenger car repairs, there is no set rule as to the classification of output. At the present time, on the New Haven, passenger car repairs are divided into two main classes—general and minor. In a general repair the paint is burned off; in a minor repair it is not. While it may be true that the heaviest expense in connection with the ordinary repairs to steel passenger cars is in the painting, such a segregation is of little value on a road where there is a consistent program of installing steel underframes or re-building trucks on wooden cars or making extensive renewals of plates on steel cars. In other words, this segregation may be a fairly reasonable one for the New Haven at the present time, where there is a large percentage of comparatively new steel cars and there is relatively less work being done on wooden cars. When the steel cars are older and there must be extensive repairs to the side plates on account of rusting around window sills, eaves, etc., the present classification will be comparatively worthless. On another railroad we found a dining car which was substantially re-built, costing \$25,000. This job, under our classification, would be placed in the same class as a coach on which the ordinary general repair work was done, costing about one-sixth as much.

“On the Boston & Maine where there is a much greater proportion of wooden car work and where there has been a consistent policy of installing steel underframes, quite a different classification is used. It is my understanding that until recently, the amount of money spent, as well as the character of work, was the measuring stick of the class of repair, but that the money basis has been entirely eliminated. Under the present basis, a Class A repair involves new steel underframes, new trucks, and general repairs; a Class B, steel underframe or new trucks and general repairs; Class C, a wooden floor section or alteration

and general repairs; Class D, sheathing and splicing and general repairs; Class E, light repairs. Even this segregation, however, assumes that the work under general repairs will be in proportion to the balance of the work. Moreover, the cost of one car can be 100% in excess of the cost of another car, and still be in the same class. I have not attempted to make a classification of passenger car repairs, but I cannot believe that it is impossible to make a classification superior to that which is in effect on either road. I know that as far as the New Haven classification is concerned, many attempts to equate the number of repairs to a common denominator and to make a comparison of the cost per unit of output in different periods has invariably come to naught. The character and the amount of work within each class varied so greatly that equating on any sound or accurate basis was impossible.

"It seems to me that the standard hour can be used here to excellent advantage. It provides an accurate measuring stick of just what work was put on the car, not on the basis of the time actually spent, but upon a standard time for doing that work. With a standard time, the same performance each time is given the same credit and the sum total of the operations can be expressed in the common unit of standard hours. If it is desired to maintain the present classes, such as the division of the Boston & Maine repairs into five classes and the New Haven's into two, the output can be expressed in ratios of a general repair or a minor repair as measured by the relationship of the standard hours of each actual job to the average or normal standard hours for doing the ordinary amount of work for that class.

"As to the costs of repairing passenger cars, there is almost a complete lack of information. Frequently, not even the costs of repairing individual units or classes of equipment are kept. Such was the situation on the New Haven until fairly recently, when a system was instituted by which the cost of repairing passenger cars was kept separately for each unit repaired. These units are then combined into classes, so that we receive monthly reports showing the cost per car for general and minor repairs divided as between steel and wooden cars and divided among

the various classes—coach, baggage, combination, mail, milk, etc. These figures in themselves are extremely valuable. We have gone further than this, however, and have subdivided the car so that we will obtain currently the information for the following sub-groupings:

- Scrubbing,
- Trucks,
- Platform,
- Electrical work,
- Inside carpenter work,
- Outside carpenter work,
- Tinsmith work,
- Pipe work,
- Painting,
- Buffing,
- Upholstering,
- Trimming.

“With such subdivisions it is possible to determine and check separately the operations of the various departments, and by applying the standard hours for the various operations we are able to tell the efficiency of the various departments. Where work is delayed in the shop or where the cost is too high, it is possible to tell readily and quickly where the weakness lies.

“Locomotive maintenance is a more important, a more involved and a more expensive operation than the maintenance of passenger cars, but such a large portion of our mechanical men are locomotive men that the great importance of checking passenger car maintenance is sometimes overlooked.

224. *Freight Car Repairs.*

“What I have said with reference to passenger car repairs applies equally to freight car repairs. As far as the output is concerned, there has been a tendency toward greater uniformity. The classes of freight car repairs are, for the most part, based upon the number of man hours for doing the work. On the Boston & Maine a general repair must take 200 man hours or over; a heavy repair from 20 to 199 hours, and a light repair from 1 to 19 hours. On the New Haven a Class 1 repair is anything in excess of 175 hours; a Class 2 repair 73 to 175 hours;

a Class 3 repair from 37 to 72 hours; a Class 4 from 21 to 36 hours and a Class 5 repair under 20 hours. As far as the general subdivision between heavy and light is concerned, the New Haven and the Boston & Maine are on the same basis. The objection to the man hour basis of subdividing freight car repairs is the same as that applying to the classification of passenger car or locomotive repairs in accordance with money spent. The greater the efficiency of the force, the less credit is given in the way of units of output. The more extravagant the management of the plant in expending man hours, the heavier the class of repairs. This objection could readily be removed, if, instead of the actual hours, the standard hours were used. The objection to the actual hours is well shown by an example in a shop on the New Haven. When the bonus system of payment was introduced in this shop, the efficiency of the force gradually increased. With the additional compensation and the realization on the part of the men that they would receive as much in increased earnings as their efficiency permitted, the performance improved more. Almost all of the work being done at this shop was rebuilding of steel coal cars, a Class 1 repair. Yet, because most of the work was being done in less than 175 hours, this shop was being credited with a large number of Class 2 repairs, simply because the efficiency of the force had increased to that extent. If the standard hours had been used in this case, there would have been no difference on account of the increase in the efficiency of the force and the number of units of output would have been the same in the later as in the earlier period. It is not, however, necessary to use the standard hour where the data are not available from which standard hours can be compiled. The important classes of freight car can be subdivided just as in the case of locomotives, and the classification made to depend upon the extent of the renewals of floor, sides, roof, sills, trucks, etc.

“From the standpoint of costs, we should have for freight car repair either the cost of the individual jobs or the cost by classes of cars. On the New Haven we receive monthly the costs of heavy repairs to box cars, coal cars, flat cars, and refrigerator

cars. In addition, as in the case of passenger cars and locomotives, we are arranging to obtain the information as to the cost of repairing the different parts of the car. In this case, the subdivisions are as follows:

Stripping,
Jacking up,
Trucks,
Underframe,
Draft gear and couplers,
Stringers and flooring,
Framing,
Inside lining,
Outside sheathing,
Roofing,
Door track and doors,
Brake and pipe work,
Safety appliances,
Painting and stenciling.

"In this way it is possible not only to keep track of the cost of doing the various kinds of work, but by a comparison of the standard hours it is possible to tell the relative efficiency of various groups of men doing the different kinds of work.

"It is quite likely that, as I have enumerated at great length the various reports and kinds of information which seem to me to be of value to the mechanical officer, I have given you the impression that he should be spending most of his time analyzing reports rather than observing the work being done. You may have a picture in your mind's eye of being buried in daily, weekly, and monthly reports of output and costs by classes of equipment, by classes of repair and by classes of work. Before leading to that impression, however, I ask you to keep in mind that I am enumerating the various kinds of information which seem to me to be valuable. Elaborate reports are not valuable. The fewer the reports and the more simple they are, the better, but if we are to have any reports at all (and it is obvious that we must have some), those reports should be sufficiently comprehensive and accurate that they will be informative rather than provocative. They should give information rather than suggest questions. All of the information which I

have suggested need not be used, nor need all of it be sent to all officers. It is obvious that the amount of information needed by the mechanical superintendent need not be as detailed as that made available to the shop superintendent, and the information for the general manager or other executive officers should be in considerably less detail than that available for the mechanical superintendent. If, however, the reports are outlined properly, the same basic data can be used for them all, the amount of detail being less for each grade of officer receiving any information as to shop output and costs.

"The bonus and piece work systems each give the basis of a considerable amount of information. They are based upon the same principle; namely, that a man should be paid on the basis of his efficiency, and his efficiency is judged by the relationship of the time he uses in performing various pieces of work as compared with a proper or standard time of performing the same work. From a statistical standpoint, the bonus method has the advantage of necessarily providing almost all the information for producing valuable statements of performance and cost. In other words, under piece work it is only necessary to know the number of units of work of the various classes done. In order to compute the pay of the workmen with the bonus, it is not only necessary to know what he has done, but the time that it has taken him to do it. Under the bonus not only the amount but the percentage of bonus paid increases with the efficiency of the work. We, therefore, have the standard hours and the actual hours of various operations, and these can be combined to provide units of output, units of cost, and the efficiency of the performance of various kinds of work. Furthermore, this information can be obtained with little, if any, increase in the clerical forces. In checking the number of additional men needed as piece work inspectors with the number of cost clerks used under the bonus plan, the relationship of additional men to the number of mechanics, helpers, etc., seems to be almost the same under the two systems. From a strictly statistical standpoint, therefore, I have been favorably impressed by the enormous amount of data made available by the bonus

plan, not as a part of that plan, but entirely incidental to it. On that account, I felt that our own road should be able to obtain all the necessary data for the close checking of its mechanical operations without any expense in addition to that called for by the bonus plan.

"It is not, of course, necessary to adopt a bonus plan in order to obtain the information made available by it. Cost time-keeping systems make available the same information. In the latter, however, the obtaining of the statistical data is absolutely essential to the success of the plan, and the use of such data by the supervising officers is also necessary. In the bonus plan the statistical data are incidental and the urge to better performance comes from within the man rather than from without. The cost of installing a cost time-keeping system is probably as great as that of the bonus. Its success is doubtful unless the supervising forces take hold of it and use it to its utmost. Under the bonus, every man in the shop is interested in making the plan work just as soon as he realizes that he can profit from it himself.

"But whatever the plan, whether piece work, bonus, or cost time-keeping, information is available for elaborate analysis of the work done and the cost of doing it. The question immediately arises whether, once compiled, it can be used. There are not enough hours of the day for mechanical officers to intelligently analyze the immense mass of information. Nevertheless, it does not seem to me reasonable that because there is a large amount of data, it is on that account useless. It is not necessary to check each kind of operation each day, week, or month. The system of sampling and of analyzing cross-sections of the work is being found more and more useful and satisfactory. We are using it in transportation statistics, where there is also an immense mass of information. Different phases of operations can be checked in a general way each month and a detailed analysis made once in several months. In this way, it is possible to use the immense mass of mechanical statistics by having a few simple reports currently, and by making detailed analyses periodically. For example, in checking the output of

a locomotive shop, we could have our cost per unit of repair by classes of locomotives and by classes of work, together with the output, expressed in number of units equated on the basis of standard repairs or the number of classified repairs subdivided into 15 rather than 5 classes. This information would not take long to analyze currently. Then periodically we could analyze the cost in detail of the boiler work, or the valve motion work, the tender work, rods, etc. Occasionally we could test out the cost of maintenance of different types of parts about which more information is needed. On this basis the amount of time necessary for the analysis would not be great and this fund of available information could be used. Surely, if there is information which presents the facts in a true light, we should be able to find a way of using it.

“I will leave these two thoughts as I close: First, we should not assume that our costs are low and our performance excellent simply because no one can prove that they are not; and secondly, because it may require intensive analysis and considerable expense to obtain accurate facts as to the efficiency of our mechanical performance, we should not assume that it is worthless to assume the expense until we have made the effort.”

CHAPTER XXXVII

ECONOMICS OF LOCOMOTIVE OPERATION

225. *Economic Factors.*

No current discussion of the subjects of locomotive operation and maintenance would be complete without reference to the comprehensive paper prepared by Mr. L. K. Sillcox, of the Chicago, Milwaukee & St. Paul Railway, and presented by the Railroad Division of the American Society of Mechanical Engineers at the spring meeting of the Society, May 18-21, 1925.

This paper, which we reproduce in full, is deserving of the most careful study, as it goes into the problem of locomotive operation and maintenance in a most thorough and understandable manner, as follows:

“The successful manufacturer must know the units of cost to produce his wares, for upon their application depend his profits. The universal adoption of more or less detailed cost accounts in both large and small establishments and the greater scrutiny given to them by owners and managers are real evidence of the value of such knowledge and the necessity therefor. Knowing that such information is successfully determined and applied in the commercial world, surely it can be as effectively established and employed in the matter of railroad-locomotive maintenance and be the basis of executive policy with a view toward assisting the average motive-power man in carrying out evident possibilities for economy and an effective procedure at least cost.

“Economies are of two kinds: internal economies which can be carried out independently by the mechanical officer of his own motion; and the much greater economies which management, as a whole, can only make possible, based on current studies as to policies and possibilities. Perhaps one main reason

why the justice of the principles above stated is not more readily conceded is to be found in the fact that it is oftentimes regarded as exceptional. The truth would rather seem to be that railroads are only typical of the more modern business organizations, and should seriously study, regardless of known obstacles, what the possibilities really are, and then constantly endeavor, item by item, to make progress along fundamental lines; all of which, for the purpose of our discussion, revolves around the question of the proper utilization of motive power. In truth, though we have emphasized the point of management policy and imagined an executive fixing a complete system, yet no one man, and indeed no combination of men, could evolve a best method off-hand from the foundation. It can only grow gradually, developing here and changing there, in line with economy, as the territory requires or the nature of the traffic and the competition in attracting it become an issue. But the guiding idea of management having a proper and stable policy remains the same throughout.

"The serious question we have before us is the necessity of deciding upon an accurate unit of measure. We need correct and simple facts, susceptible of a clear and concise understanding on the part of all concerned, and clear as well as quick application by railway officers charged with the duties of maintenance and operation. The expenditure for locomotive maintenance so far as it is caused by frictional wear and tear will evidently increase in direct proportion to the strain of the work imposed upon the locomotive; at the same time, to the extent it represents outlay for replacement of parts, obsolete though not worn out, so far it is independent of work done. Any plan used in the shopping of power involves complete consideration as to necessary maintenance and the effect from characteristics of service, as well as details of motive-power construction, age and availability of shop, roundhouse facilities, etc.

"Maintenance may be defined as the upkeep or replacement of parts as due, based on individual consideration of each item with respect to limits of wear, strength requirements, and reliability factors. The accounting for the cost of maintenance

varies with the type of property. Maintenance of locomotives, for instance, when finally accumulated for the year and reported as required by the Interstate Commerce Commission's classification of accounts, embraces not only the labor and material applied together with the allocation of direct overheads, such as shop expense, power-plant distribution, store expense, etc., but the depreciation and retirement charges. The carrier has the option of determining the rate at which depreciation shall be charged and accumulated currently, but the general principle is to apply a rate somewhat consistent with the estimated total life after deducting the estimated amount of salvage recoverable when the unit is dismantled. Any depreciation which is not sufficient when a locomotive is retired is made up by retirement charges applied against the locomotive-maintenance account at the time of dismantling; therefore equipment maintenance is charged currently with paying off the investment as well as overcoming wear and deterioration.

"The maintenance of fixed structures, such as bridges for instance, is charged currently as actually incurred, no depreciation being accumulated during the life of the bridge, but the entire investment being charged off to operating expenses at the time of final retirement. Taking these facts into consideration, therefore, a fixed structure, having a longer life than equipment, requires a lesser rate of renewals, and a bridge costing new \$64,000 as compared with a new locomotive costing the same amount will incur a final average charge for maintenance and retirement of approximately 4 per cent as compared with approximately 15 per cent per year for a locomotive. However, in considering the subject as a whole from an equipment standpoint, we are able to segregate the direct repair cost from other charges, the repairs being confined to a sub-account in the classification, which involves labor plus shop expense, and material plus store expense. It is a fact that in not a few instances much of the expenditure for locomotive maintenance, as reflected in the accounts, is occasioned from patching up old construction, even though in some cases this does extend to the point where the actual repair cost, as renewed, exceeds the major portion of the

value of the unit as renewed and, consequently, is recapitalized; in which event, nevertheless, the retirement expense must be carried in maintenance.

226. Folly of Continued Obsolete Designs in Service.

A close study will very often indicate the folly of spending large sums per unit to continue obsolete designs in service for long periods when the same amount would be more than sufficient, as an initial cash payment, for an up-to-date efficient design of greater capacity and less cost to operate or maintain. Let us test this by imagining a concrete case. Assume that a passenger engine fifteen years old and originally designed to handle a nine-car train is now required to carry fifteen cars on the same schedule, resulting in a heavy maintenance cost due to frame breakages, racking of machinery, valve motion, running gear, etc. Then it becomes a question of not only maintenance but investment. If the original unit was of 40,000 lb. tractive effort and was costing an average of \$9,000 per year to maintain with a relatively low record of 3,000 miles per month, then it would seem proper to consider a new type of power, say, with 50,000 lb. tractive effort which would afford 5,000 miles of service per month and yet not cost more than \$5,000 per year for maintenance, making a saving of approximately \$4,000 per year in maintenance cost and increasing the performance 66 per cent. This would justify making a change in power even though the original unit might have cost \$30,000 and the new unit would cost \$60,000. The original unit involved a maintenance cost of \$9,000 per year plus a depreciation charge of \$750, or a total of \$9,750 as compared with an estimated maintenance cost of \$5,000 per year for the new unit, plus \$1,500 depreciation charges, or a total of \$6,500, making a saving in the new unit of \$3,250 per year, to say nothing of additional savings in fuel and transportation expenses. At 6 per cent this recovery would represent an investment of \$54,000, or almost the cost of the new unit, but if this were done on a large scale then the amount of work would be performed with 66 per cent of the number of new units as compared with the number of old units, and thus the change

would be justified. It should be understood, however, that passenger service is more constant than freight, so that this example is not presented with the idea that such a reduction in the number of units is possible in passenger service, but is more applicable to freight service.

"The extent to which carriers are developed along this line reflects in a general way upon the maintenance policy and the cost. Obsolescence of locomotives is a very indefinite measure and its application, in general, is entirely according to local conditions. A locomotive will grow obsolete and costly to operate even if it only remains standing, and this same factor will become of increased importance if it is kept constantly in operation for a long term of years without substantial improvement to care for advanced practice, due to transportation losses from excess fuel consumed or questionable reliability in service affecting train movements. For this reason it would seem a wise plan to obtain all the mileage possible from locomotives, so that the time when they are worn out may arrive at least as soon as the stage when they become out of date.

227. Policy Used in Shopping Power a Central Factor.

The same idea of promoting efficiency may be applied to the method employed in shopping locomotives, all of which resolves itself largely into a consideration of the program or the plan employed as best suited by any given administration. There are many elements in the matter of executive policy which go to make a relatively high or low maintenance cost, and the method of shopping power is one of the primary features to be considered. It is possible to hold different opinions as to the attitude which it is proper to assume, but aside from the variation in the characteristics of power owned, when comparing the performance of a number of administrations it may be said that the policy used in the matter of shopping power becomes a central factor and may be considered as the hub of the force at play. The range of possibilities in any given case may be easily determined from a study of practices obtaining on various systems, but, as a matter of fact, there are two extremes, with many varia-

tions between them. One is what may be termed the "high-frequency-shopping" and the other the "low-frequency-shopping" policy. The high-frequency-shopping policy is that based on running locomotives through shops with an anticipated service of from twelve to fourteen months with a minimum of roundhouse attention. The low-frequency-shopping policy is that based on running locomotives through shops with the idea of having a service of 24 months or more and with a greater degree of roundhouse attention to attain this length of service.

Vital elements in determining such a policy are the relation of the number and size of locomotives owned to the business handled, the road conditions for hauling heavy- or light-tonnage trains, the topography of the country traversed, the distribution of industrial centers, the presence of large terminals, the spacing and capacity of roundhouses, the distribution and assignment of power, the placement of forces as between roundhouses and back shops, the rapidity with which mileage is run out, and particularly the roundhouse and back-shop facilities for handling certain classes of work. Furthermore, where a railroad has back shops of an obsolete character it is practically as well off doing its work in roundhouses, and it may be found helpful under such conditions to construct small modern back-shop facilities at critical points to care for division requirements without increase in overhead expense.

228. Trend of Unit Costs Since 1910.

"The results obtaining under the two extremes of policy mentioned have been observed for a considerable period, and it appears that policy is largely governed by local conditions rather than local conditions being governed by policy. The road with which the author is connected has had experience under both plans, and just as a case in point, the general results obtained will be stated. Prior to 1921 a high frequency of back-shop repairs was employed, but after considerable study the plan was changed to a low frequency of repairs. The trend of unit costs, etc., both prior and subsequent to 1921, is illustrated in Fig. 1.

This chart is a graphic illustration of the results obtained under these two extremes of policy, affected, of course, by the price trend of labor and material in the meantime. The lines

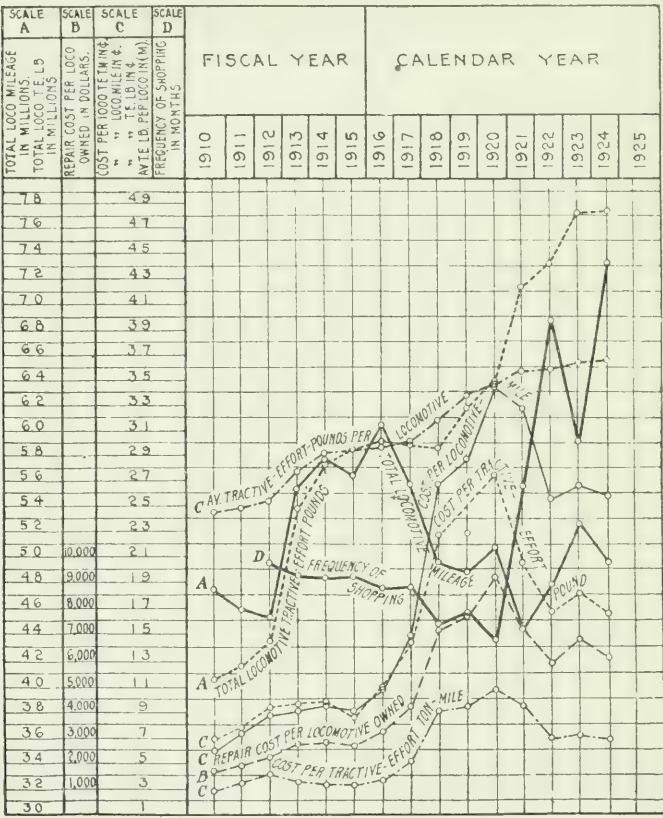


Fig. 1.—Data of Steam-Locomotive Repairs and Performance, C. M. & St. P. Ry., 1910-1924

plotted represent three general groups, one indicating the growth and size of units maintained, another the various unit costs of maintenance, and a third the frequency of back-shop repairs. The growth of property maintained is represented by the dotted

line *A*, which indicates the total tractive-effort pounds owned from 1910 by years to the end of 1924. This growth was not all in the nature of new equipment but represents power added by the acquisition of subsidiary and leased lines as well as some new equipment, and to that extent the growth line should not be confused with the rate at which new equipment might have eliminated obsolescence. This very fact has a marked bearing on the cost of maintenance, as the total growth consisted of approximately as many of the smaller and older locomotives as of the acquisition of the larger and newer types.

"As to whether or not this extension of property was consistent with the growth of business naturally depends upon how the acquired lines may have increased the amount of business in relation to the amount of property. It is not desired to elaborate here upon the principles of the proper rate of growth of property, but merely to state that the method of computing the proper growth would be to determine the gross revenues per locomotive owned, affected somewhat by the characteristics of the lines added as to their ability to function on a high or low unit train-tonnage basis. Nevertheless the growth of property represents a serious problem in the matter of having back-shop development keep pace with it and of getting continuous use from power.

"Fig. 1 also shows the increase in the average size of locomotive owned. The size of locomotives is an element in the unit cost of maintenance, and it will be noted that this figure increased from approximately 24,000 tractive-effort pounds per unit to 36,000 in 1924, or approximately 50 per cent. The chart is confined to steam locomotives only, electric locomotives being a separate and distinct problem. It is not possible to state whether the growth in locomotive ownership increased more or less than the revenues or the average train load, as these data are not available from the subsidiary and leased lines.

"The feature in Fig. 1 which is deserving of closest study is the line *D* representing the frequency of back-shop repairs. This is arrived at by dividing the total yearly classified-repair output into the total owned throughout the year, which expresses the

number of years between shoppings thus developed, and this of course varies from year to year according to the difference in the number of locomotives owned or used and the output. This is based upon a classification of repairs instituted during Federal Control and is translated back to 1912. This classification runs as follows:

- "CLASS 1: New boiler or new back end. Flues new or reset. Tires turned or new. General repairs to machinery and tender.
- CLASS 2: New firebox, or one or more shell courses, or roof sheet. Flues new or reset. Tires turned or new. General repairs to machinery and tender.
- CLASS 3: Flues all new or reset. (Superheater flues may be excepted.) Necessary repairs to firebox and boiler. Tires turned or new. General repairs to machinery and tender.
- CLASS 4: Flues part or full set. Light repairs to boiler or firebox. Tires turned or new. Necessary repairs to machinery and tender.
- CLASS 5: Tires turned or new. Necessary repairs to boiler, machinery, and tender, including one or more pairs of driving-wheel bearings refitted.

General repairs to machinery will include driving wheels removed, tires turned or changed, journals turned, if necessary, and all driving boxes and rods overhauled and bearings refitted, and other repairs necessary for a full term of service.

Running repairs unclassified.

Suffix 'A' to any class of repairs will indicate that the repairs are required on account of accident.

'B' will show the initial application of stoker.

'C' will indicate the initial application of superheater.

'D' will indicate the initial application of outside valve gear.

'E' will indicate locomotive was converted from compound to simple or from one type to another.

Mallet locomotives will be indicated by a star following application.

Locomotives receiving Class 1, 2, or 3 repairs must be put in condition to perform a full term of service in the district and class of service in which they are to be used.

Class 4 repairs not less than $\frac{1}{2}$ term.

Class 5 repairs not less than $\frac{1}{4}$ term."

"It may be generally conceded that the above is not sufficiently specific to be a complete measure of output, since the

divisions are not based on work units to a great enough degree to permit of judging shop output in detail.

229. Cost of Repairs per 1000 Tractive-Effort Ton-Miles.

“The variation in the trend of line *D* is entirely dependent upon the allotment of labor and materials available for maintaining equipment. The shopping frequency increased gradually from 1912 to 1920, and during the latter year locomotives were going through at the rate of once every 14.28 months. In 1921 a committee was appointed to report upon the economics of shopping power, as a result of which it will be noted there was a radical change in the frequency of back-shop classes of repairs subsequent thereto. This study related particularly to the situation existing on the Chicago, Milwaukee & St. Paul Railway and is not offered as a criterion for the reason that other conditions often determine whether or not such a policy is applicable to any but a specific case. The frequency of shopping trend, expressed both in years and in months between shoppings, was as follows:

Year	Years between shoppings	Months between shoppings
1920	1.19	14.28
1921	2.20	26.40
1922	3.30	39.60
1923	2.50	30.00
1924	3.70	44.40

“The change in plan necessarily brought about some modification in the distribution of machine tools and facilities in back shops and roundhouses. Great care had to be employed to avoid deferred maintenance under such a transition because of the high cost incident to overcoming deferred maintenance promptly and adequately were this condition to have obtained. The roundhouses were partially equipped to do the necessary machinery and running repair work and in some cases rather heavy boiler work, so as to properly maintain the power for longer periods, some of the facilities being transferred from the

back shops to the roundhouses. The back-shop forces were reduced in proportion. Prior to the change all judgment as to months good for, miles to be run between shoppings, etc., was based on the theory that locomotives were good for a term of 12 months only, and consequently a large amount of data was prepared to show that this attitude was not in keeping with the operation of the property and therefore should be adjusted to the new method. Prior to 1921 there was no specific application of the plan of assigned mileage to be used as a basis for shopping power. This method was put into use at that time and a statement prepared showing the expected mileage to be run out after each classified repair, divided according to types of power. It is important that the same mileage should not be applied to the same type of power regardless of where or how used, and in this respect an assigned mileage for each class of service, type of power, and for each division instead of for the system as a whole is necessary in practice, otherwise classified repairs will be made in roundhouses, but not so reported, in order to avoid breaking the mileage. The method of breaking mileage varies throughout the country, but this does not affect the data used here.

"As to the results obtained from this change of plan, it should be understood that there have been some wage and material price variations since 1920, but these adjustments account for approximately 14 per cent of the reductions attained. The cost trends on the chart merely indicate the actual reductions, with no separation between fluctuations in the cost of material and labor, shop efficiency, etc. The cost per locomotive-mile during the high-wage period of 1920 reached 34 cents when the shopping frequency was 14.28 months, but after the frequency of back shopping was reduced the cost steadily declined and in 1924 was less than 26 cents. This represents a reduction of approximately 24 per cent. The cost per tractive-effort pound was reduced from 27 cents in 1920 to 16.5 cents in 1924, or 39 per cent. The cost of repairs per locomotive owned was \$9,300 in 1920 and \$6,000 in 1924, or a reduction of 35 per cent. The cost per thousand tractive-effort ton-miles was reduced from 1.075

cents in 1920 to 0.676 cent in 1924 or 37 per cent. In the meantime the average size of locomotives increased 6 per cent.

The method of measuring the cost of repairs per tractive-effort ton-mile was to take the tractive-effort pounds owned, reduce them to tons, multiply by the miles run in thousands, and divide this into the cost of repairs, Account 308. (This unit should not be confused with ton-miles hauled; it is entirely independent of the rate of grade or curvature and is merely the force of one ton acting parallel with the rails and at the circumference of the drivers through a distance of one mile.) Expressed as an equation:

$$D = \frac{C}{\frac{A}{2000} \times \frac{B}{1000}}$$

where

A = total tractive-effort pounds owned

B = total locomotive miles run during year.

C = cost of repairs, Account 308, or exclusive of depreciation, retirement, etc.

D = cost of repairs per 1000 tractive-effort ton-miles.

As previously stated, there were reductions in wage rates and cost of material in this period, so that the entire reduction is not to be credited to the change in plan referred to.

"Finally, we have seen that this principle of shopping locomotives is in no sense special or peculiar. As to whether or not a policy as outlined could be taken as a criterion, it would be difficult to state. The plan was adopted for the C. M. & St. P. system because it appeared to be properly applicable. It is a matter of interest in this connection, however, to make a study of ten carriers where there is a wide range of policy, using the same units outlined above. The value of the units used cannot be considered as entirely intrinsic and for that reason the method employed should not be considered as absolute. The chart of Fig. 2 is offered as a result of a study of various carriers, some having a high-frequency and some a low-frequency method. In plotting the data, scales were used merely to throw relative items

together in order to indicate those which run in a certain ratio and those which run inversely. The horizontal scale is the average tractive-effort pounds per locomotive owned—to show the size maintained. The data are based on 12 months in 1924.

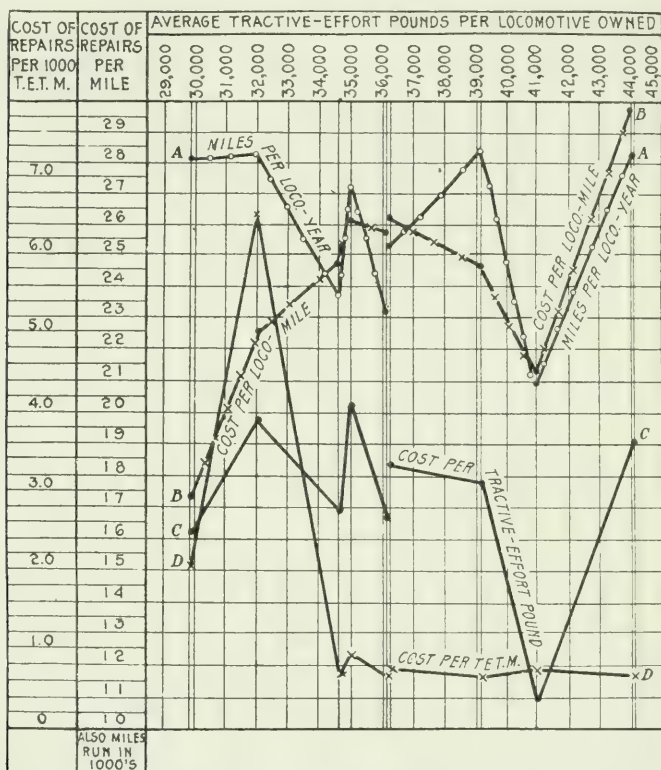


Fig. 2.—Comparison of Cost of Maintaining Steam Locomotives Considering Average Size, Average Miles, and Cost of Repairs Per Mile Per Tractive-Effort Pound and Per 1000 Tractive-Effort Ton-Miles

"Another point may be observed. In the matter of performance the average miles per locomotive run per year is given by line A. This shows a difference in performance which does not follow relatively the variation in size of power, indicating many degrees in intensity of use, etc. The mileage ranges from 20,800 to 28,500 per locomotive per year. The carrier with the largest

size of power made practically the same mileage per locomotive as the one with the smallest size of power shown on the chart, whereas those administrations with locomotives of a size ranging between the two extremes made less mileage per locomotive. This may be considered an element of performance and demand characteristics of the lines involved. In this case the highest mileage was 37 per cent greater than the lowest shown.

"The cost per locomotive-mile as shown by line *B* is low for the carrier having the smallest size of power, being less than 17.5 cents, and is high for the one having the largest size of power, the upper range being a little less than 30 cents per locomotive-mile.

"The average size of power expressed in tractive-effort pounds was 47 per cent greater in the largest average size as compared with the smallest average size, whereas the cost per mile was 71 per cent greater for the larger than the smaller power, so that it may be said that in this case the cost increased one and one-half times as the unit size of power increased. This figure is not in itself entirely significant.

"The cost of repairs per tractive-effort pound being a measure of size only, does not run in direct ratio with the increase in size. It will be noted that while the smallest size of power has the lowest cost of repairs, the largest size of power does not have the highest cost of repairs, both being exceeded by carriers having locomotives of intermediate capacities. The composite factor of cost of repairs per thousand tractive-effort ton-miles, consisting of the size and mileage, ran somewhat inversely with the capacity of power owned, with variations in the intermediate sizes. Here it is interesting to note that the smaller size of power cost more than the larger, the result being due in this case to the carrier with the larger power running about the same mileage per unit as the carrier with smaller power.

"There would be no profit in going further into details, since these data are presented merely as a matter of comparison and to illustrate the fact that it is most difficult to establish a criterion or a specific policy which is applicable in all cases. Road characteristics, density of traffic, and many other elements

must be considered in any calculation that aims to be complete and conclusive. However, in general it has been found that carriers using large-size power have a fairly high frequency of back shopping, which is of great interest in this study because it is evidence, for the most part, of intensive use and a more or less uniform power demand. Thus far the frequency has been stated in terms of time only. It is affected very largely by the rapidity with which mileage is run out, and therefore, in a general way, reflects whether carriers are long or short in their power ownership.

"These data indicate that as the average tractive-effort pounds owned increase, the cost of repairs per mile increases in a rather definite way; that the average miles per locomotive run and the average cost of repairs per tractive-effort pound have the same range characteristics; and that the average cost of repairs per thousand tractive-effort ton-miles varies somewhat inversely with the average tractive-effort pounds per unit owned, with intermediate fluctuations.

"In using tractive-effort ton-miles as a unit of measure in this case it should be understood that there is a variable feature in the actual amount of capacity employed as compared with the maximum available. The larger units may or may not exert as great a percentage of the total tractive effort as the smaller units, and to the extent of this variation this measure must be considered only with the knowledge thereof. Here again maximum or ruling gradients, scheduled tonnage, etc., are factors showing how near the capacity available is utilized as compared with the maximum at hand, and the studies given here are made only with the intention of indicating that, regardless of any units of measure used, there are local conditions which determine the differences in the showing made and that these are usually found to justify the outcome. The tabulations are therefore presented with the necessary reservations as to limits of their scope. This unit of measure does not include the work performed, that is, the tonnage hauled, which if added would doubtless give trends differing from those shown on the chart; but the tonnage hauled is a matter of record in freight perform-

ance only, whereas the data thus far considered apply to all classes of power.

"Statistics are now available to show the gross ton-miles per freight-train-hour, which is a fair measure of locomotive performance when considering the average size as well as the number of units employed. This reflects efficiency in train handling as well as corresponding utilization of power, and where there is prompt turning in roundhouse care and running repairs fewer locomotives may be used for a given traffic, thus building up a reserve and maintaining a proper shopping period. It is necessary, of course, to apply such data to road engines only, and this can be done with the information at hand. The variation among carriers in such performance is quite extreme, some having as high as 26,000 and others as low as 12,000 gross ton-miles per train-hour. This difference is far greater than the average size of power and other influencing factors such as grades, curvature, signal stops, etc., would indicate, and leaves open to study the question of greater development along the line of utilization of power and consequent shopping methods.

230. Effect of Specific Shopping Policy on Cost of Repairs.

"Just what effect the specific policy followed has upon the trend of the cost of repairs is not thoroughly ascertainable, but it would seem that a minimum cost may be expected when it has been definitely established that a proper balance between classified and running repairs has been arrived at. No specific formula for reaching this division has yet been developed. A study of the cost of repairs per mile divided between running and classified work does not present a solution, because whenever it is necessary to decrease or increase forces and expenses, the fluctuation is felt directly in the back shop, and only indirectly in the roundhouse. It is generally known, of course, that whenever it becomes necessary to curtail expenses or make reductions, it is a simple matter to close the back shops but not possible to make corresponding reductions in roundhouses because certain forces must be maintained in the latter at all times, and under such circumstances even in larger number. For that reason run-

ning-repair costs follow a more uniform trend, and the policy of the extent to which engines are given running repairs in roundhouses must be fashioned according to the relation of road time to time allowed for turning, which is largely affected by the units available for service call. Running repairs are not so directly affected by the disposition of revenues as classified repairs except where the carrier is in a position to enjoy revenues which exceed the expenses to such a degree as to constantly insure earning the net requirements. There is no argument against the great need of having uniform forces and avoiding the closing of shops, because excessive fluctuations in forces cause repair programs and the continuity of work to be disrupted, and in addition destroy discipline. Shop output is, generally speaking, directly affected by fluctuations and expenses, and this seriously affects the frequency of classified repairs.

“One way of measuring performance with shop output is to compile the locomotive-miles run since last shopping, setting this up in a cumulative way monthly and comparing it with the miles restored in classified repairs. The miles restored must necessarily be based on the assigned mileage, and the balance between miles run out and restored cannot be accurately judged unless the assigned mileage is practically correct and consistent with actual performance. When the assigned mileage is set too high, then there will be more restoration of mileage reported by shop output than is actually run out; on the other hand, if the assigned mileage is too low, then the restoration is not in keeping with the run-out mileage. The experience of the C. M. & St. P. along this line has developed the fact that the application of the assigned mileage for each type of power, regardless of its use, is not sufficiently specific, and such process, when employed, needs revising by developing an assigned mileage for each type of power and for each division so that the local characteristics as to track, curvature, gradients, service, consequent tire and lateral wear, and boiler repairs can be considered as factors. Theoretically it is possible to group repairs into time cycles, but time is only one of the elements of shopping power, and as the frictional wear is mostly overcome in roundhouses the time element

for shopping power resolves itself very largely into cycles based on necessity for heavy boiler repairs.

“The factors used by the C. M. & St. P. in the general plan of shopping are assigned mileage, time, and actual physical condition based on customary and frequent inspections. Where there is a low rate or run-out mileage, time enters into the calculation to a greater degree than where mileage is run out rapidly. Physical condition is a vital element to overcome the differences in divisional characteristics or variations in the service rendered according to track, water, and other features. In addition, it can be arranged to set a limit to expenditures for the various types of power according to the class of repairs to be given, any over-expenditure to be reported and explained so that extraordinary repairs may be a matter of record. The regulation of frequency of repairs to locomotive parts is a matter of long-range study and the cycling of repairs cannot be followed specifically in all cases, although it has been the company’s general policy to endeavor to follow a class No. 3 repair with a No. 4 or No. 5 and then with another No. 4 or No. 5 followed by a class No. 3; in other words, having two minor repairs between two major repairs; but this depends upon the nature of service performed and the severity as well as the rapidity with which mileage is run out. It cannot at the outset be presumed that we can obtain approximately 50 per cent of the mileage between classified repairs for the first class No. 3 repairs and then 25 per cent for each of the minor repairs, as experience has developed that inasmuch as taking up lateral, tire turnings or changes, etc., constitute a classified repair, tire and lateral wear develop and become due for renewal just as soon after a class No. 3 as after a class No. 4 or No. 5 repair; so that it is well to contemplate a distribution of the mileage and make it equal for each class of repairs, whether a No. 3, No. 4, or No. 5 class, but regulate the cost of each shopping accordingly.

231. *A Study of Enginehouse Operation.*

“A study of shop and roundhouse facilities cannot be summarized in terms of specific units so as to outline the direct effect

upon policy and the results thereof. It involves the number of roundhouses per mile of track, the frequency of turning locomotives or the miles run between turnings, etc. As a matter of interest, it may be stated that during the time in which the change in policy referred to was taking place, studies were made of enginehouse operation not only as to repairs made but as to the cost of turning power, frequency of turning, etc., with results shown in the table immediately following:

	Transportation Expense (Not Maintenance)		
	1922	1923	1924
Average turnings per month.....	53,572	59,784	54,911
Average cost per month.....	\$430,492	\$384,969	\$331,830
Average cost per engine turned....	8.30	6.44	6.04
Average cost per engine-mile, cents	10.25	8.35	7.68
Average miles run between turnings	78	77	78

"No comparison can be made with other carriers in this respect because the methods of counting engines turned, the accuracy of distributing charges, the nature of roundhouse facilities, etc., vary too greatly. The above figures are merely given to show that the trend in other expenses affected by locomotives was downward the same way as indicated in Fig. 1. It is very apparent that the frequency of turning power decreases with the increase in average distance between roundhouses, and that the average miles per engine turned will increase with the spread in distance between roundhouses. This naturally involves the general study of utilization of power.

"A statement of the actual hours of service per engine per day reflects the intensity of use and efficiency in turning, all of which depends largely upon the condition of power, the amount owned, and the character of maintenance. We have not been able to observe any adverse effects on the turning of engines because of decrease in frequency of back-shop repairs; it might have been assumed that so low a frequency as was developed in the change of policy would throw too much of a burden upon roundhouses for intermediate repairs and increase the hours of detention. The cost per mile of running repairs incurred in roundhouses is greater than the cost per mile of classified repairs

made in the back shops, the former running rather uniformly with the number of engines turned and the latter fluctuating more in relation to increase or decrease in operating expenses because of regulating them according to revenues.

“The formulation of a specific policy of back-shop attention to power, therefore, must consider a wide scope of performance, embracing the amount of property owned in relation to the demand and use thereof, the type and size of power, shop and roundhouse facilities and their relation to each other, road conditions, rapidity with which mileage is run out and restored, the ability to maintain a minimum but uniform force in back shops throughout the entire year, the ability in addition to increase the rate of repairs in the low-peak-loading months so as to have a larger supply available for service in high-peak months, the range of variation between high- and low-peak months, etc. Where back-shop and roundhouse facilities are modernized and properly regulated by means of machine tools, power plants, handling devices such as cranes, hoists, tractors, manufacturing devices and an adequate store stock, it should be possible to determine closely the final balance between classified and running repairs with its relation to the cost of performance expressed in various units of measure, some of which have been outlined above.

232. Bearing of Utilization of Power on Shopping Policy.

“The utilization of power requires careful and detailed study because any variation must of necessity have a marked bearing upon shopping policy. It has been found when comparing the performance of a greater number of carriers than used in plotting Fig. 2 that the tendency to run out locomotive-miles rapidly increases somewhat with the increase in size of power, and, as before stated, the rate at which mileage is run out is a determining factor in the proper frequency of classified repairs. There is a great variation in the mileage performance, and this reflects either good or poor power assignment and use, or a high or low density of traffic. Where the percentage of locomotives required for business is large in relation to the total ownership,

where the monthly mileage is high, and where the hours of service per day are above the average of eight, this reflects a small reserve for detention in and awaiting shops, and the back-shop efficiency is then a more vital factor and the time consumed in making repairs is a greater element than where opposite conditions prevail. The average number of days out of service for the item of in and awaiting shop is not a matter of uniform record and therefore is not always available, but it is well to make mention here of the importance of having for this purpose a detailed knowledge of the number of days locomotives are out of service. It is possible to arrive at the average days of detention in the past so as to regulate the future by the use of the following formula:

Let A = average number of locomotives in and awaiting shop
per month

B = total locomotives owned

C = total days in the year and

D = frequency of shopping

Then

$$\frac{A}{B} \times C = \text{Average number of days detention per locomotive per year}$$

and

$$\frac{A}{B} \times C \times D = \text{Number of days detention per shopping.}$$

"In cases where the percentage of power in service is low as compared with the total owned it is usually found that the hours of service per day are low or approximately six, which makes it possible to have a large waiting list and to turn locomotives less rapidly through the shops and still have ample protection for service. It would be expected that where the average size of power was small there would be more units out of service than where the average size of power was large, other things being equal, but on the other hand the data supporting the chart indicate that where large power runs out mileage as rapidly as small power it incurs a greater frequency of back-shop repairs, probably due to terminal facilities not having been improved to

the same extent* as the motive power. With some carriers the shopping detention is serious, while with others it does not create a problem; yet the tendency should be to increase the utilization of power, and increased utilization will depend largely upon its condition and the degree of maintenance.

"A campaign along the lines of reducing the number of units in active service to a minimum consistent with traffic handled, based on the average miles per locomotive despatched or the average miles between locomotive turnings (enginehouse operation) will necessarily avoid the purchase of new equipment for the purpose of increasing the complement, because when longer runs are installed and fewer locomotives are used for a given service, this naturally builds up a surplus. With a surplus of power the shopping problem is less acute. Where the gross ton-miles per train-hour indicate a slow movement in a territory where traffic is dense, trains should not be delayed because of short runs made by locomotives and frequent delays due to changing power. Movement in this case requires acceleration, and to overcome this trouble it is necessary not only to increase the length of locomotive runs but to eliminate intermediate terminals and classify trains so that the local service will be confined to the fewest possible trains, permitting a greater number to proceed without such interruption. Intensive service requires a revision of the method of repairs, and in some cases calls for a higher standard of repairs than where more locomotives are used in the same service. The objective should be to get more locomotive-miles per month out of fewer active locomotives and more hours of service per day out of each locomotive; then other factors will naturally increase the gross ton-miles per train-hour.

"Turning to the problem of the time element applied to locomotive output, where orders are issued to shops for locomotives of a certain character to be made ready for service on short notice, the time factor, as regulating the date of delivery, is very often a matter of supreme importance. A study of this question very soon brings to light an intricate problem with which supervisors and others in authority have to grapple. One of the out-

standing factors is that of the machine-tool and material-handling equipment, with which is identified the means of producing work rapidly and to the best advantage. Many of the latest machine tools, cranes, tractors, etc., are conspicuous for the facility with which they can be operated, the controls being conveniently placed, thus saving time in setting up and subsequently handling the machines. Another equally vital point is that of the organization of the work, which must, if time is to be saved, be planned on a definite and progressive system. All these measures are applicable to old as well as to the most modern new shops; however, they are likely to lose much of their value unless the workmen themselves co-operate in the avoidance of time wastage. Slackness in commencing work when first arriving at the shops or in resuming after an interval may result in an aggregate representing a very considerable loss of time, and make it difficult or impossible to get the engines completed to schedule. Similarly, stopping unnecessarily soon each day before the whistle blows, if indulged in on anything like a wide scale, must necessarily reduce the effective value of the working day. Piece-work and unit-output-measure systems are designed to make such action on the part of the workmen unprofitable to them, but even where these are in force it is often found impossible to correct the loss. It is therefore only through the strict co-operation of every one concerned, combined with proper shop systems and the use of tools and facilities fully adapted to their purpose, that rapidity of production can be assured.

233. *Conclusion.*

“One point of serious practical importance remains, namely, that the designated mechanical officer should place before his executive a practical and sound analysis of the requirements for the upkeep of motive power, shops, power plants, and tool equipment, and recommendations for expansion or rehabilitation to save against existing unit expense known to be out of keeping with the possibilities for best achievement. It is also desirable to view the problem from the standpoint of (1) Performance, (2) Cost, and (3) Progress.

“In making submissions for proposed expenditures they may be grouped under items or savings as dealing with:

1. Fuel
2. Labor
3. Materials
4. Delay to Train Movements
5. Accident Prevention or Personal Injury

“Once we have grasped these fundamental facts, we can promptly get rid of not a few popular fallacies already referred to. It is regrettable and not a little surprising that in fixing ordinary running expense and upkeep the budget allowance to be approved by any administration should fail to be based upon the requirements as made necessary because of traffic or operating conditions and complying with a general policy formulated to properly care for conditions in the most effective and economical manner, and not altered to fluctuate with current temporary drops in traffic, which are often seasonal. Where there is an increase or decrease in business handled during a long period it is necessary to modify the assignment of forces employed in such a way as will permit of increasing forces economically, that is, gradually, if materials and facilities are in readiness to absorb the advantage of greater forces to be employed, and to decrease them without permitting the property to depreciate or build up deferred maintenance.

“Such changes in the budget should never be made without the most careful consideration of all phases of the problem, based on considerations of a broad policy. For instance, during the course of five or ten years the traffic on a given property may warrant certain expenditures for maintenance of locomotives, shops, power plants, tool equipment, and new locomotives; this expenditure should be made constantly each and every year. The policy of trying to maintain an even or favorable allocated net earning capacity each month, regardless of the business handled, in order to save against financial fluctuations as to credit or stock issues, acts to cause a considerable influence to make administration difficult, particularly during low seasonal movements. An accumulative allocated net trend, with a full

knowledge of balances between losses and gains, should permit of a more even flow of maintenance work. Unless this is done a stable policy cannot readily be worked out or maximum economy obtained with a minimum outlay for facilities and for labor. What should be arrived at is a reasonable maintenance standard for the property as a whole. The basis should be gauged from a consideration of the general earning capacity and also upon the kind and class of traffic handled. With this part correctly fixed, slight fluctuations in business should not materially alter the yearly progress as applied each month with the view toward stability of employment and proper discipline and administration of the work.

"In a large sense the motive-power man is only as successful as his management will let him be. This is one of the reasons why so many able men have left the railroad service for other and more productive fields. Every motive-power man of wide experience knows what a lack of executive support or full co-operation means. The best policy on earth avails little if it does not have support from the top of the organization down. Too many of our executives judge the mechanical man by locomotive-miles produced, without any direct reference to work done by the locomotives, which is a vital factor. It is for this reason that data were presented here to indicate not only mileage performance, but a composite factor of mileage and size or capacity.

"One other point in conclusion: It has frequently proved to be the case that, regardless of all of the devices and methods employed to increase the efficiency of power, the personnel and organization employed are the most important in this respect. There is a great difference of opinion as to whether or not a locomotive is due for shopping. Judgment in this respect varies, but the basis depends largely upon training and the policy adopted, whether expressed or implied. The psychology of high or low frequency varies. The human factor in shopping policy is as vital as the material factor."

CHAPTER XXXVIII

CANADA'S RAILWAY TRANSPORTATION SYSTEM

[The following outline of the steam railway transportation system of the Dominion of Canada is included in this volume because of the desirability that everyone occupying a position of responsibility on American railroads should have at least some knowledge of the development of that system and of its relation to the Government and people of the Dominion.]

234. Two Great Railway Systems.

Steam railway transportation in the Dominion of Canada is now comprised in two systems. Control of these is concentrated in the hands of two organizations, the Canadian Pacific Railway Company, privately owned, and the Canadian National Railways Company, which represents an experiment in government ownership.

As a country of magnificent distances, with a relatively small population, and large areas of undeveloped territory, Canada presented unusual problems to the railroad builder, but it was recognized even before Confederation in 1867 that cheap transportation was a necessity of national life. Up to 1850 the water routes were the chief avenues of transportation, and as these were closed by ice for several months in the year, business in large sections of the country was necessarily condemned to stagnation for a long period annually. Economic development of the Dominion therefore demanded the steam railway, in order that the vast productive areas of western Canada might be linked up with the industrial sections and world markets. An era of railroad construction then began with the Canadian Pacific Railway project, and the opening of that road gave length to Canada, as an economic unit, but, as has been well said, it was "length without breadth." Then followed the construction of other transcontinental railways, now grouped in the Canadian

National system, and these gave the country the "breadth" which it formerly lacked and which ultimately, with immigration and settlement of the areas thus opened up, is expected to assist materially in the economic development of the Dominion.

The steam railway mileage of Canada at the date of the last official report was 39,773 miles. During the year 1922, 495 miles of new line were opened for traffic; 267 miles were completed, but not opened for operation, and 1,115 miles were under construction. These are not net figures, however, as there was considerable mileage shortened and lifted where conditions warranted the change. The mileage by provinces December 31, 1922, was as follows: Ontario, 10,881; Saskatchewan, 6,267; Quebec, 4,977; Alberta, 4,680; Manitoba, 4,585; British Columbia, 4,374; New Brunswick, 1,947; Nova Scotia, 1,451; Prince Edward Island, 278; Yukon, 58; and in United States, 273 miles.

235. *Early Canadian Railways.*

Railway construction in Canada began in the year 1836, when a line was built between St. Johns, Quebec, and LaPrairie, 16 miles, to shorten the journey between Montreal and New York. It was first operated by horses, but locomotives were substituted in 1837, and ten years later a second railway from Montreal to Lachine was opened, with a third line to St. Hyacinthe in 1848. In all of Canada, there were only 66 miles of railway in 1850. In the following year, however, steps were taken to construct a main line of railway between Upper and Lower Canada, resulting in the completion of the Grand Trunk Railway between Montreal and Toronto in 1856. Three years later the line was extended westward to Sarnia and then eastward to Riviere du Loup. The Grand Trunk then leased the Atlantic & St. Lawrence Ry., running from Portland, Maine, to the Canadian border, and with the completion of the Victoria bridge across the St. Lawrence at Montreal, the company in 1859 had a through route 800 miles long from Portland to Sarnia. Subsequent leases included a line from Detroit to Port Huron, in 1859; the Champlain roads, 1863; the Buffalo & Lake Huron, 1867, and in 1880 the Chicago & Grand Trunk was completed

from Port Huron to Chicago. The gauge was originally 5'6", but this was changed to standard gauge in the '70s. In 1881 the Georgian Bay & Lake Erie system was incorporated, with 171 miles; then came amalgamation with the Great Western, 904 miles, and the Midland system, 473 miles. In 1888 the Grand Trunk took over the Northern Ry., which had been opened from Toronto to Barrie, Ont., in 1853; also the Hamilton & Northwestern Ry., while direct communication with the railways of the United States was established in 1891, with the completion of the St. Clair tunnel.

236. *The Intercolonial Railway.*

Construction of a railway to unite the Canadas, Upper and Lower, with the Maritime Provinces had been proposed as early as 1837, and in 1844 a survey was made for a military road as an Imperial Government project. This fell through because of differences of opinion as to route, but in 1853 the province of Nova Scotia undertook to construct a trunk line from Halifax to the New Brunswick frontier. Lack of funds in both provinces prevented carrying out the scheme for an Intercolonial railway, and when the British North America Act united the provinces as the Dominion of Canada in 1867, there were only 341 miles of railway in the so-called Maritime Provinces, including 196 miles in New Brunswick and 145 miles in Nova Scotia. These lines, under the terms of Confederation, passed to the Dominion government, which then undertook the completion of the Intercolonial Ry., and in 1876 the line was opened. In 1879 the Intercolonial acquired the Riviere du Loup branch of the Grand Trunk, but it was not until 1898 that connections were made with Montreal, when the Intercolonial secured running rights over the Grand Trunk tracks and was thus enabled to compete for the business of the chief commercial center of Canada. It was the agreement incorporated in the British North America Act to unite the Maritime Provinces with Quebec and Ontario by a railway which largely operated to induce New Brunswick and Nova Scotia to join the Dominion. The admission of British Columbia in 1871 was likewise effected by the

offer of the Dominion to build within ten years a railway connecting that province with the eastern part of Canada, and this promise was fulfilled by the construction of the Canadian Pacific Railway.

237. *The C. P. R.—First Transcontinental Railway.*

In its early efforts to carry out the contract of union with British Columbia, the Dominion government became convinced that the rapidity desired in the construction of a transcontinental line could only be accomplished by private enterprise and central control. Consequently the government sought a group of capitalists to undertake the task, and success was eventually obtained. In June, 1880, it was announced by Sir John Macdonald, then premier of the Dominion, that the necessary co-operation of capitalists had been secured. Conclusive evidence was at hand of the ability of Canada to support a transcontinental railroad, and to overcome the barriers which had long held back its development. The economic development of the country became adjusted to its national development; the project which had been broached as early as 1849 was brought within the realm of practicability, and the contract for the construction of the Canadian Pacific Railway was signed on October 21, 1880.

It is interesting to note that the plan first adopted was that the railway should be built in sections by the government, but the difficulties involved were such that, under the contract of 1880, the work was turned over to a syndicate which undertook to form a company to build a road from a point near North Bay, Ont., to the Pacific, for a cash payment of \$25,000,000 and 25,000,000 acres of land in what was known as the "fertile belt." Certain sections of the line which the government had already built, or was building, were also turned over to the company. The contract also provided for free admission of materials for construction and protection for twenty years against competing lines. This was the origin of the Canadian Pacific Railway Co., which has since become one of the most powerful corporations in the world, controlling 13,442 miles of railway. The company

agreed to complete the line to a fixed standard by May 1, 1891, and thereafter to maintain it efficiently. The first sod was turned on May 2, 1881, and as a matter of fact the last spike on the main line of the C. P. R. was driven on November 7, 1885, five and one-half years ahead of time.

Among the capitalists associated with the enterprise were the following representative men: George Stephen, afterward Lord MountStephen, president of the Bank of Montreal; R. B. Angus, manager of the same bank; Hon. J. Cochran, a Quebec cattle breeder; Duncan J. McIntyre, manager of the Canada Central Ry., and Donald A. Smith, afterward Lord Strathcona, chief commissioner of the Hudson Bay Co., who, though his name was omitted from the contract, was of the greatest importance to the project as representative of immense land holdings in the Canadian west. James J. Hill, owing to his large interest in the St. Paul, Minneapolis & Manitoba Ry., was also an influential supporter of the C. P. R., foreseeing the effect which its construction and the development of traffic in Western Canada would have on the earnings of his line to Winnipeg. P. DuPont Grenfell, senior member of Morton, Rose & Co., and the American branch, Morton, Bliss & Co., represented English capital, while the possibilities of colonization and emigration were recognized in the interest of Reinach & Co., of Paris and Frankfort, and of the Société Générale of France.

The government grant of land to the C. P. R. was given in alternate sections of 640 acres, 24 miles deep on each side of the railway from Winnipeg to Jasper House, and sections unfit for settlement and deficiencies were made up by grants of land between parallels 49 and 57 degrees of latitude, or by a similar grant along the company's branches. To facilitate the company's financial arrangements, provision was made for the issue of land grant bonds to the extent of \$25,000,000, besides the cash subsidy already mentioned. These bonds were deposited with the government, one-fifth being retained as security and the remainder sold, the proceeds being paid to the company as the work progressed. The government aid was given according to the difficulties of construction. The less difficult territory 900

miles west of Selkirk was granted \$10,000 and 12,500 acres per mile; 450 miles west of this line, \$13,333 and 16,666.66 acres per mile; and from Callander to Lake Superior, \$15,384.61 and 9,615.35 acres per mile. Payment was made with the completion of every twenty miles, but power was given the company to requisition an advance of three-fourths of the value of steel rails delivered. Land was also granted for roadbed and railway purposes, and power given to locate the main line from Callander to Lake Superior, and from Selkirk to Kamloops by Yellowhead Pass, and to locate branch lines. The material required for construction and operation, and the capital stock, were exempted from taxation forever, and the land was exempt for twenty years after the grant.

Subsequent legislation permitted the company to locate its main line from Selkirk to the junction with the western section at Kamloops by a more southerly route than that by way of Yellowhead Pass, and in March, 1882, the company was able to announce the location of 1,650 miles of track. Construction rapidly followed location until the main line was completed in 1885, but before that time the Canadian Pacific began to acquire small branch lines as feeders. Thus the North Shore, Quebec, Montreal, Ottawa & Ontario was acquired in 1881; the Winnipeg to Manitou line in 1882, the Ontario & Quebec, the Credit Valley, and the Toronto, Grey & Bruce in 1883; the St. Lawrence & Ottawa and Manitoba Southwestern in 1884; the North Shore, Nova Scotia, in 1885; the Atlantic & Northwest in 1886; the West Ontario Pacific in 1887; the Sudbury & Sault Ste. Marie in 1888; the New Brunswick Ry. and the Columbia & Kootenay in 1890, and the Montreal & Ottawa and Montreal & Lake Mas-kinonge in 1892.

The terms of the contract made by the Dominion government with the Canadian Pacific Ry. Company were designed to develop the trade of the Northwest and of British Columbia, and to divert that trade from the United States to eastern Canada. Under conditions of extreme government liberality, therefore, the road was constructed through the long stretch of unproductive and difficult territory north of Lake Superior, and traffic

was developed in western Canada by means of various devices and with the utmost rapidity. Private enterprise having undertaken the task, it was carried through to a successful conclusion, by virtue of the liberality of the terms of the contract, the general attitude of the Canadian government, the spread of population in the western States, the completion of the St. Paul, Minneapolis & Manitoba Ry. to Winnipeg, and the knowledge gained of the nature of the task in the earlier years when a sum exceeding \$37,000,000 was expended by the government in the construction of the lines afterward turned over to the company.

"The addition of the Canadian Pacific Railway to the technological equipment of western civilization, and the conditions under which it was accomplished, have had many and varied effects," says Harold A. Innis, Ph.D., in his comprehensive history of the enterprise. "Settlement was advanced in every possible way. Immigration increased rapidly as a result of the efforts of the company and of the government. Branch lines were laid out, first in the territory south of the main line and later throughout the entire area. These branches were strategically located, with reference to possible competitors, to the development of traffic, and to the sale of the company's land. The marked increase in the production of grain and especially of wheat in western Canada, stimulated by efforts to develop traffic and favored by a world movement characterized by a general rise in the price of wheat, and its diversion over lines to eastern Canada, made necessary the improvement and increased control of transportation facilities in the latter area. According to plan, the economic development of the west stimulated the economic development of the east. The marked prosperity of Canada, especially from 1896 to 1913, paralleled the prosperity, the expansion, and the integration of the Canadian Pacific during that period. Following the general progress of Canada, occasioned by the opening of the west, advantage was taken by eastern Canada of stimulating progress still further by the construction of the Canadian Northern and the Grand Trunk Pacific. To the difficulties which overtook these roads were added the difficulties of the Intercolonial and the Grand Trunk, which suffered

losses partly as a result of the effectiveness of competition from Canadian Pacific lines in eastern Canada. Such were some of the important effects of the construction of the Canadian Pacific Railway."

238. *The Canadian Northern Railway.*

The second transcontinental railway of Canada, the Canadian Northern, started in 1896, when the 125-mile line of the Lake Manitoba Ry. & Canal Co., chartered in 1889, was completed by Mackenzie & Mann, noted as railroad builders and promoters. The Canadian Northern had the co-operation and material assistance of the Manitoba provincial government, whose purpose was to establish competition with the Canadian Pacific; and it was thus enabled to secure the Manitoba lines of the Northern Pacific. The charters of several other roads had been previously acquired, these including the Winnipeg & Hudson Bay, the Manitoba & Southeastern, the Ontario & Rainy River, and the Port Arthur, Duluth & Western. In 1902 the Canadian Northern completed its line from Winnipeg to Port Arthur, and by the aid of bond guarantees from the Dominion and provincial governments it was enabled to complete the scheme of a great transcontinental road which opened up in Ontario and in the west large undeveloped areas, now in course of settlement.

239. *The Grand Trunk Pacific.*

While the Canadian Northern was in process of development to transcontinental magnitude, and before its ultimate plans were publicly realized, the scheme of a third transcontinental line began to take shape. In the late '90s the Grand Trunk was attracted by the possibilities of the still undeveloped west, in view of the large and increasing revenues being drawn by the Canadian Pacific from the territory which it had succeeded in opening to settlement and trade. Consequently, in 1902 the Dominion government received a proposal from the Grand Trunk for the construction of a line from North Bay to the Pacific coast. In aid of this project the Grand Trunk company

asked for a subsidy of \$6,400 and 5,000 acres of land per mile. The government, after an interval of consideration, proposed that the line, instead of terminating at North Bay should be carried east to Moncton, New Brunswick, and offered to construct the easterly section from Moncton to Winnipeg and lease it to the Grand Trunk for 50 years. No rent was to be paid for the first seven years, and 3 per cent of the cost of the line for the remaining 43 years. The Grand Trunk was to build the western half of the railway, from Winnipeg to Prince Rupert, the government guaranteeing interest on bonds up to 75 per cent of the cost of construction, not exceeding \$13,000 per mile on the prairie section and \$30,000 per mile on the mountain section. This offer being accepted, construction began on the National Transcontinental and the Grand Trunk Pacific railroads, these being respectively the eastern and western sections of the third transcontinental railway of Canada. These plans, with the subsequent effects of the World War, lead measurably to a radical change in the railway policy of Canada and the development of the Canadian National Railway system.

240. Effects of the World War.

In the period between 1900 and 1915, with two additional transcontinental lines, with branches, under construction, the railway mileage of Canada was doubled. In 1900 it was 17,657 miles; in 1915, 35,582 miles. Railroad expansion had been entered into with the confident expectation of government and people that European immigration and capital would flow into the areas tributary to the new roads and provide traffic for them, as had been the case with the C. P. R. Then came the war, with serious results for the new enterprises, including a cessation of economic development, scarcity of labor and material, and high costs of operation. In 1915 and again in 1916 the Dominion government was compelled to give financial assistance to the Grand Trunk Pacific and the Canadian Northern; and a Royal Commission was appointed to investigate (1) the general problem of transportation; (2) the status of each of the three transcontinental systems, (3) the reorganization of any of the said

systems, or their acquisition by the state, and (4) other matters considered by the commission to be relevant to the general scope of the inquiry. The members of the commission originally were Alfred H. Smith of New York, Sir Henry Drayton of Ottawa, and Sir George Paish of London. On the resignation of the latter, William M. Acworth took his place, and the majority report of Sir Henry Drayton and Mr. Acworth, known as the Drayton-Acworth report, has been the basis of nationalization of railways in Canada, with the notable exception of the Canadian Pacific. Their recommendation was that the public should take control of the Canadian Northern, the Grand Trunk Pacific, and the Grand Trunk proper; and that they should be administered on purely business principles by a board of trustees; "such compensation as seemed proper to be decided by arbitration and given to the shareholders of the Canadian Northern and the Grand Trunk."

241. Government-Owned Railways of Canada.

When the Grand Trunk Pacific Railway Co. failed to take over the operation under lease of the eastern division of the National Transcontinental Ry. on its completion in 1915, the government itself undertook its operation. The capital expenditure on this road up to Dec. 31, 1922, was \$169,090,122. The Intercolonial Ry. and the Prince Edward Island Ry., completed in 1875, have been owned and operated by the Dominion government since their construction, and the total mileage of the government railways on March 31, 1918, was 5,150.08 miles, comprising the Intercolonial, 2,305.23 miles; the St. John & Quebec Ry., leased in 1912, 127.72 miles; the Prince Edward Island Ry., 313.82 miles, and the National Transcontinental Ry., 2,403.31 miles. In 1918 and 1919 several small roads were incorporated in the government system; and the Hudson Bay Ry., with 332.5 miles of steel rail at the end of 1920, and 214 miles operated, out of its total length of 424 miles, has been declared to be comprised in the government railways and is being operated to a limited extent by the board of directors of the Canadian National Railways. Its cost to Dec. 31, 1922, was \$20,569,266.

Government control of the Canadian Northern Ry. was acquired by act of the Dominion Parliament in 1917. In September, 1918, the government appointed a new board of directors for this company, and this board also became a board of management of the Canadian government railways. The term "Canadian National Railways" to describe both systems was authorized by order-in-council of Dec. 30, 1918, the corporate entity of each system being, however, preserved. When acquired by the government the Canadian Northern system had a total mileage of 9,566.5 miles.

The Grand Trunk Pacific Ry., after receiving advances from the government in 1916, 1917, and 1918, found itself in difficulties and notified the authorities that it would be unable to continue operation after March 10, 1919. The minister of railways was accordingly appointed receiver from March 9, and after a period of independent operation the management was transferred to the Canadian National Railways in October, 1920.

Negotiations were begun early in 1918 for the inclusion of the Grand Trunk proper in the government system. Parliament in 1919 passed an act authorizing the government to acquire the Grand Trunk by purchase of the preference and common stock, the value of which was to be determined by arbitration. On certain other stocks the government agreed to guarantee the payment of dividends and interest, provided the voting powers of the stockholders should be surrendered. The government assumed its liability under the act of May 31, 1920, and the arbitration proceedings commenced on Feb. 1, 1921. The arbitrators appointed were Sir Walter Cassels, chairman; Sir Thomas White, for the government, and Hon. William H. Taft, former President of the United States, for the Grand Trunk. Further legislation provided for the resignation of the English directorate, the substitution of a Canadian board, and the establishment of the head office of the Grand Trunk in Canada. The award of the arbitrators was made on Sept. 7, 1921. The chairman and Sir Thomas White held that the preference and common stocks had no value, in view of the financial condition of the Grand Trunk, consequent upon the Grand Trunk Pacific en-

tanglements. Mr. Taft, dissenting from this opinion, held that these securities should be valued at not less than \$48,000,000, his contention being that the stocks would be earning dividends in five years' time. An appeal from the majority decision was taken to the Privy Council by the shareholders and dismissed on July 28, 1922.

The Grand Trunk arbitration cleared the way for the consolidation of the Canadian National Railways under government operation and control. In October, 1922, the resignations of the Grand Trunk board were formally accepted and a new board was appointed by order-in-council to act as directors of both the Canadian National and Grand Trunk railways. On its first meeting in Toronto the members of the new board were formally elected to the Canadian National directorate, replacing the Canadian Northern board, whose resignations had been tendered and accepted by the Minister of Railways. The management and operation of the Canadian government railways was handed over to the new Canadian National Railway board by an Order-in-Council on Jan. 20, 1923. One week later the unification of the Grand Trunk and Canadian National railways was provided for by another Order-in-Council, which also gave effect to the act "to incorporate the Canadian National Railway Company and respecting Canadian National Railways." This was followed immediately by an order establishing the head office of the Canadian National Railways at Montreal. Sir Henry Thornton had been appointed chairman of the board and president of the Canadian National Railways, coming to the position with a fine record gained in the American and British railway service and by his personality establishing from the start a large degree of public confidence in the success of the Dominion experiment in government ownership.

Addressing the Montreal Board of Trade, December 5, 1922, Sir Henry Thornton set forth his aim "that the Canadian National Railways should be put upon a self-supporting basis and the burden on the purse of the taxpayers should be stopped as quickly as possible." It was also stated that "the government

has elected to administer the National Railways in substantially the same way as though they were privately owned."

242. *Three Regions for Operating Purposes.*

After due consideration the new management divided the combined and reorganized National Railway system into three regions for operating purposes, as follows:

Atlantic Region.—All lines in the Maritime Provinces and as far west as and including Rivière du Loup, on the Intercolonial, and as far as but not including Monk on the Transcontinental; headquarters, Moncton, N. B.

Central Region.—All lines from Rivière du Loup and Monk, P. Q., to Current Junction, on the Canadian Northern, two miles east of Port Arthur, and to Superior Junction, on the National Transcontinental, and including the Portland line and the lines west of the Detroit River; headquarters, Toronto.

Western Region.—All lines from Current Junction and Superior Junction, Ont., to the Pacific coast, including Vancouver Island; headquarters, Winnipeg.

The Central Vermont, for the present, to be operated as a separate entity, with headquarters at St. Albans, Vt.

243. *The Problems of Reorganization.*

As to reorganization of the Canadian National Railways, Sir Henry Thornton stated in a communication to the Dominion Parliament on March 27, 1923, that when the new management took charge, about December 1, 1922, there had been three primary problems which demanded immediate attention, namely, (1) the determination of the kind of an organization which was to be employed in the administration of the property; (2) the determination of the regions into which the property was to be divided for operating purposes and the location of regional and general headquarters; (3) the selection of officers for the various posts involved in the organization.

The organization which had been decided upon, said Sir Henry, was what might be called a strengthened divisional organization, as distinguished from a departmental organization. The executive officers consist of a chairman and president, as-

sisted by five vice-presidents, as follows: 1, vice-president in charge of operation, maintenance, and construction; 2, vice-president in charge of financial affairs; 3, vice-president in charge of insurance, immigration, development, lands, express, and telegraphs; 5, vice-president in charge of traffic.

The above executive officers represent the minimum with which, in Sir Henry Thornton's judgment, it would be possible to operate such a property as the Canadian National Railways; and as time went on, he said, it would probably be necessary to add another vice-president.

In dividing the system into three regions for operating purposes, continued Sir Henry, the principle followed had been to give to each operating region as much autonomy and local control in the actual operation of the property as was consistent with efficient principles of administration. Every effort would be made to confine the functions of the vice-presidents and the executive officers to policies, leaving to general managers, general superintendents, and superintendents the responsibility of carrying out details. He felt that in the administration of such a large property as is represented by the Canadian National Railways no other theory of organization could be successful. In conclusion Sir Henry Thornton made the following suggestion:

"In the organization of such a property, where we employ about one hundred thousand people, scattered over nearly 23,000 miles of line, the process of consolidating and harmonizing the various forces is one which will necessarily take some time. It is therefore earnestly hoped that those who administer the affairs of the nation will be sufficiently patient to give those who are sincerely, honestly, and conscientiously working out this problem an opportunity to show what can be accomplished before criticisms are made."

244. Earnings and Operating Expenses.

The gross earnings of all steam railways in Canada for the calendar year 1922 were \$440,687,128; operating expenses, \$393,927,406.

The gross earnings of the Canadian Pacific Ry. (privately owned), including leased lines, for the same period, were \$185,188,951; operating expenses, \$147,255,641.

The figures for the same period for the roads now comprised in the Canadian National Railways were as follows:

Grand Trunk System—Gross earnings, \$77,700,719; operating expenses, \$70,317,813.

Grand Trunk Pacific, including branch lines—Gross earnings, \$18,516,978; operating expenses, \$22,809,844.

Canadian Government Rys.—Gross earnings, \$40,939,946; operating expenses, \$43,436,668.

Canadian Northern—Gross earnings, \$57,155,145; operating expenses, \$60,513,044.

The railways as a whole reduced the operating ratio from 92.26 per cent in 1921 to 89.39 per cent in 1922, and increased operating revenues by \$11,332,035, by a reduction of operating expenses. Although over five million tons more of freight were carried, and the ton-miles increased by 14 per cent through reductions in freight rates, freight revenues showed a decline of \$4,020,214, or 2.5 per cent, while with reduced rates and a decline of 5 per cent in the number of passengers carried, passenger revenues fell off by \$10,731,022, or 12 per cent, and total revenues by \$17,321,764, or 3.8 per cent. Operating expenses were reduced by \$28,653,799, or 6.5 per cent; maintenance of way and structures by \$8,380,790, and maintenance of equipment by \$3,632,815, a total of \$12,013,605, while transportation expenses were reduced by \$18,574,625, in spite of the heavier freight traffic of 14 per cent and an increase of 3 per cent in train mileage.

245. Government Ownership Forced Upon Canada.

In a symposium on social and economic conditions in the Dominion of Canada, conducted in 1923 by the American Academy of Political and Social Science, D. A. McGibbon, M.A., Ph.D., professor of political economy in the University of Alberta, said:

“The application in Canada on a large scale of the principle

of government ownership of railways is the result of a condition rather than the outcome of a theory. While there was a certain current of public opinion in favor of nationalizing the means of transportation, of itself this current had not sufficient power to commit the Canadian government to such a course. In the actual event it was to avoid a threatened collapse in national credit that the acquisition of 20,000 miles of railways was forced upon the people of the Dominion. That fact, plus the further fact that the Dominion of Canada stood as guarantor for a large amount of bonds issued by the roads in financial difficulties, were the controlling consideration in taking over the lines.

"The train of occurrences leading up to this stroke of policy is well known. The outstanding feature was the lavish encouragement of railway construction by government grants, loans, and bond guarantees. As a natural result there was over-building. By 1914 it was evident to all that the future had been over-discounted and that an exceedingly serious railway crisis was at hand, unless the body that was largely responsible for this condition stepped in and assumed the burden. With no great enthusiasm for the task, this is what the Canadian government has done."

APPENDIX

SCHEDULE REPAIR PROGRAM

PROGRESS REPORT

MONTH OF OCT. 1924

Schedule	Series	No. Cars Owned at Month	Cars Retired During Mo.	Cars Owned end of Month	Total Cars Completely Overhauled This Mo.	Total Completely Overhauled to end of Mo.	Cars remaining to overhaul at end of Month	No. of Cars Covered by AFE to Completely Overhaul	No. of Cars re-invoiced to cover by AFE to be Complete Schedule
1	51900-68198	2476	None	2476					
1	68300-69524	155	None	155					
1	70526-72524	293	None	293					
3	72526-81478	2948	4	2944					
4	81484-93480	2888	None	2888					
4	81487-83480	947	None	947					
4	500000-506204	6017	None	6017					
4	83482-87480	1860	None	1860					
5	200000-206499	6084	None	6084					
5	700000-703999	3989	None	3989					
7	506205-508204	1968	None	1968					
9	590000-590249	247	None	247					
10	206501-207470	914	None	914					
16	735-2999	631	None	631					
23	8149	1	None	1					
23	8425	1	None	1					
23	8267-12099	1059	None	1059					
23	10000-102499	2354	None	2354					
24	68695-68999	152	None	152					
27	43001-45285	1073	None	1073					
27	15001-15671	140	None	140					
27A	26001-26675	757	None	757					
27A	47401-47999	198	None	198					
29	32259-37257	2464	None	2464					
31	29677-32075	1115	None	1115					
31	300000-302499	2410	None	2410					
34	25493-25691	169	None	169					
39	48101-49999	693	None	693					
39	70001-70969	348	None	348					
42	01-0767	418	None	418					
42	0879-01340	311	None	311					
	01368-01453	39	None	39					
Total C.M. 857P		45119	4	45115	17411	151	17562	28731	22787

Fig. 1—Schedule Repair Program—Progress Report Based on Detail Reports Confined to Location

NOTE.—This report and the one on the following page were used by Mr. L. K. Sillcor, G.S.M.P., of the Chicago, Milwaukee & St. Paul Ry., to illustrate his remarks on the reports needed for "Efficient Car Department Service." See page 168, Chap. XIX.

EXHIBIT NO. 1A

SCHEDULE WORK ON CARS

September 1934.

Location	Schedule No. 3 Series: 7256-11478 Kind: Box No. Cars Owned 2948 Completed This Mo.	Schedule No. 4A Series: 8142-81480 Kind: Box No. Cars Owned 947 Completed This Mo.	Schedule No. 4B Series: 8000-20098 Kind: Box No. Cars Owned 7044 Completed This Mo.	Schedule No. 16 Series: 20951-20970 Kind: Auto No. Cars Owned 913 Completed This Mo.	Schedule No. 32 Series: 3000-30299 Kind: Auto No. Cars Owned 2410 Completed This Mo.	Schedule No. 46 Series: 2495-2491 Kind: Ore No. Cars Owned 169 Completed This Mo.	Total
Lipsa East Chicago Milwaukee Duluth Green Bay	- - 9 - -	- - 25 - -	- - 20 - -	- 24 -	6 -	- -	1 81 -
Total This Mo. Total to date	9 301	25 1368	21 1074	24 384	6 1695	- 169	88 2011
Lipsa West Deer Lodge Tacoma	- - -	9 11	- -	- -	- -	- -	- 10 18
Total This Mo. Total to date	24 234	20 1968	21 2720	24 269	6 100	- -	28 591
System	9	45	21	27	6	-	116
Total This Mo. Total to date	515 2013	679 6096	679 1196	679 201	1795 615	169 -	1302 1915
Schedule 4 and 4A work being done on one P. E. Wagon for Total Lines East Total West. Total System to date and total to be overhauled for schedule 4 includes Schedule 4A prior to date Lines East, Schedule 3 and 3A, includes 969 and 940 cars respectively, completed in contract above.							
C. R. & S. E.							
Location	Schedule No. A Series: 2001-2099 Kind: Coal No. Cars Owned 1701 Completed This Mo.	Schedule No. B Series: 6500-6999 Kind: Coal No. Cars Owned 445 Completed This Mo.	Schedule No. C Series: 11000-11180 Kind: Gondola No. Cars Owned 2114 Completed This Mo.	Schedule No. D Series: 7000-7899 Kind: Hopper No. Cars Owned 692 Completed This Mo.	Schedule No. 1-A Series: 101-190 Kind: Box No. Cars Owned 187 Completed This Mo.	Total	40 ton box cars being converted to skeleton log flat cars.
Yere Union West Clinton Bedford Chicago Ill. Car & Mfg. Co.	3 - - - -	- - - -	25 -	- -	- -	28	200
Total This Mo. Total to date	1624 17	440 5	638 1476	682 5	- 187	28 1368	192
Total to be overhauled	17	5	1476	5	187	1368	250

Office of Master Car Builder.

Fig. 2—Monthly Report of Schedule Repair Work by Stations

(See Note on Previous page.)

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